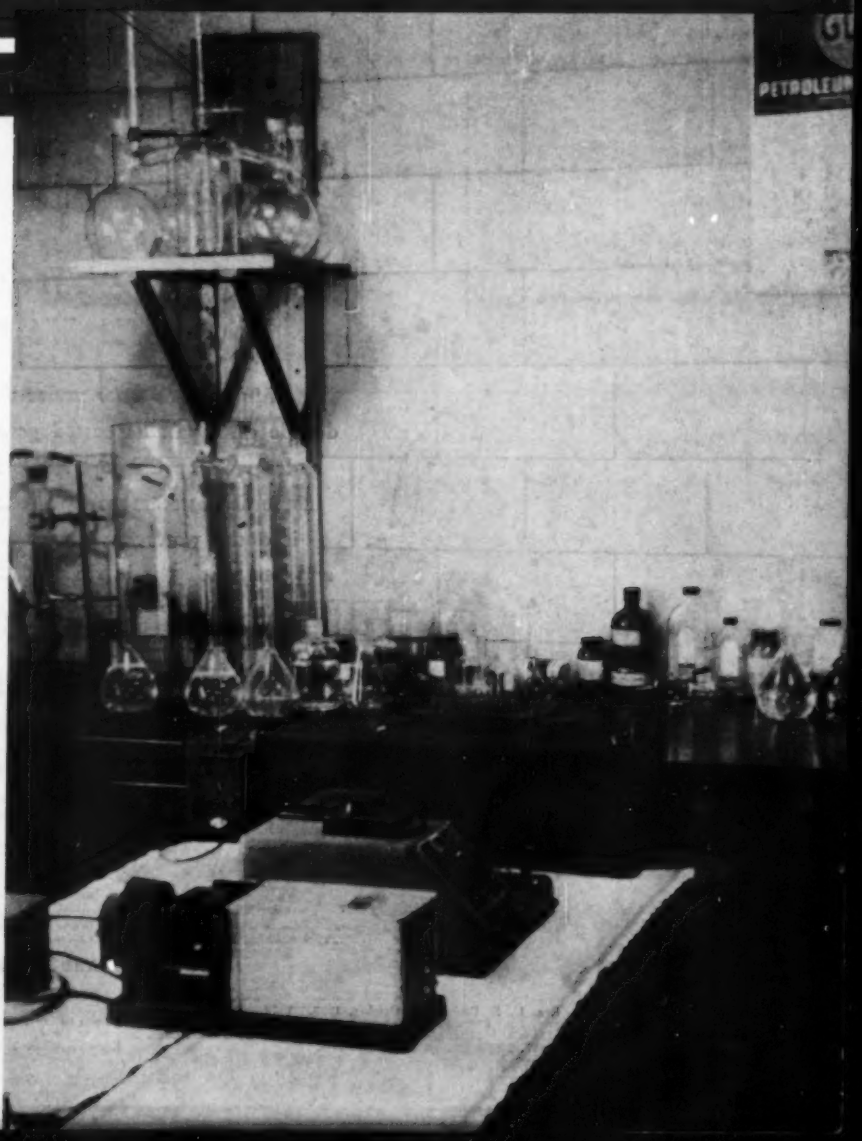
Vol. 92, No. 10 OCTOBER, 1945

WATER & SEWAGE WORKS



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A Gillette Publication

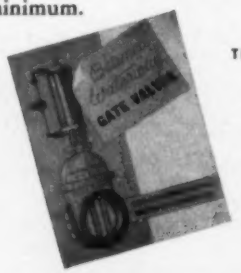
There's Less Wear...
Tighter Seating...

WITH

CHAPMAN

BEAMED WATERWAY GATE VALVES

Markedly Superior **under throttling conditions to double disc, parallel seated gate valves, is this valve designed by Chapman. The bronze vertical beams in the downstream port prevent the disc from tipping into the waterway. Bearing contact between disc and body facing is increased 6 to 10 times . . . wear is evenly distributed on seat rings . . . leakage reduced to a minimum.**



THIS BULLETIN TELLS THE COMPLETE STORY

The CHAPMAN VALVE MANUFACTURING COMPANY

INDIAN ORCHARD, MASSACHUSETTS

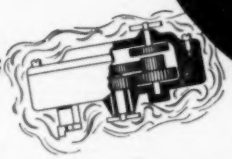
WATER AND SEWAGE WORKS. Reg. U. S. Patent Off. October, 1950. Volume 97. Number 10. Published monthly by Gillette Publishing Co., at 404 North Wesley Ave., Mount Morris, Ill. Per copy, 25c; Subscription rate: United States, $2.00 per year; Canada, $2.00 per year; Foreign, $3.00 per year. Entered as second class matter March 4, 1948, at the post office at Mount Morris, Illinois, under Act of March 3, 1879.
Executive and business offices, 22 W. Maple St., Chicago 10, Illinois. Editorial office, 155 E. 44th St., New York 17, N.Y.

DISC METER USERS . . .
LOOK AT THESE PLUS VALUES!

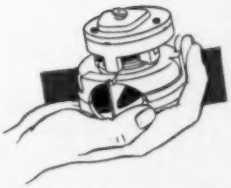
Rockwell
ARCTIC AND TROPIC
DISC TYPE
WATER METERS

REGISTERS WITH SWEEP DIAL TEST HANDS . . .

ENCLOSED GEAR TRAIN HOUSING THAT RETAINS LUBRICANT . . .



THE ECONOMY OF THREE-PART REINFORCED DISCS . . .



THE REPAIR EASE RESULTING FROM UNIT ASSEMBLY OF WORKING PARTS . . .

Rockwell brings you all these features in a *balanced* disc meter design that for many years has been noted for its accuracy and overall measurement economy.

Rockwell
MANUFACTURING CO.
PITTSBURGH 8, PA.

Atlanta Boston Chicago Columbus Dallas
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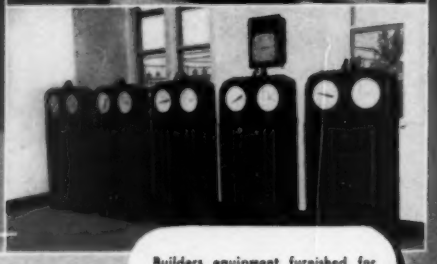
WEST PALM BEACH, FLA.

West Palm Beach Water Co.

(ADDITION COMPLETED IN 1948)

MALCOLM PIRNIE
ENGINEERS
New York, N. Y.

JOHN G. SIMMONS
Plant Superintendent
West Palm Beach Water Co.
West Palm Beach, Fla.



West Palm Beach has successfully relieved one of its major "growing pains" with this recently completed addition to the West Palm Beach Water Co. By bringing plant capacity up to 26 MGD, the modernization program has effectively fulfilled the water supply requirements of the 70,000 population in the area. The new construction conforms architecturally with the styles prevalent in this region, and is a credit to the West Palm Beach waterfront.

To meter and control the flows through the rapid sand filters, Builders Water Works Equipment has been installed. Builders Venturi Rate of Flow Controllers and Loss of Head Gauges assist John G. Simmons, Plant Supt., to maintain the plant at peak operating efficiency. For Bulletins describing Builders Water Works Equipment, address Builders-Providence, Inc. (Division of Builders Iron Foundry), Providence 1, R. I.

Builders equipment furnished for the West Palm Beach Water Co..

- **20" Model RCB hydraulically operated Effluent Rate Controllers**
- **Loss of Head and Rate of Flow Indicating and Recording Gauges with Diaphragm Pendulum Actuators**
- **30", 16" and 24" Venturi Meter Tubes with Type M Registers**

BUILDERS PROVIDENCE
Instruments

WATER & SEWAGE WORKS

WATER SUPPLY—SEWAGE DISPOSAL—INDUSTRIAL WASTE TREATMENT

E. S. GILLETTE, Publisher

L. H. ENSLOW, Editor*

COMING

Selective Use of Raw Water

Water quality problems in the east are insignificant in comparison with those of the west and southwest. This article deals with a problem requiring much study as to the most economical solution. The problem was solved by construction of a reservoir on a stream which would not provide the requirements of the city, *but* does provide an adequate supply of "dilution water" for the existing unsatisfactory river supply. As the river rises and falls in salinity and hardness more or less of the soft "dilution water" is drawn into the mixing chamber of the new softening plant, which is also described. Economy-wise the scheme is working out most satisfactorily. The Bartlesville story constitutes an interesting bit of economic engineering to provide acceptable water at minimum pumping and treatment costs. The contributor is—

W. L. PATTERSON,
Black & Veatch Engrs., Kansas City, Mo.

"Headaches, Hunches & Hard Work"

Is the title of a running series of short stories, each constituting a few pages from the life, the philosophy, and the experiences of a self-made water superintendent, who has had more than one man's share of varied experiences. These articles are both instructive, and entertaining—don't miss any of the series. The story teller is that "half-pint, do-or-die" ex water sup't. and Honorary Member A.W.W.A.

M'KEAN MAFFITT,
Former Supt., Wilmington, N. C.

Addition of Garbage to Sewage

More thought than ever is being given the matter of disposal of garbage through the increasing number of home grinders, central grinding stations discharging to sewers, and grinding at sewage works with discharge direct to digesters. These methods, as well as the quantity and character of garbage, affect sewage works operations in many ways and present a variety of problems, all of which are discussed in a thorough manner by a former sewage plant operator—

T. R. HASELTINE, Partner,
The Chester Engrs., Pittsburgh, Pa.

Modern Operation of Filtration Plants

Is the subject of a well rounded discussion of up-to-date filtration and raw water preparation practices. If you think that you know all that there is to know about water treatment and filtration practices just take another look and read this review article by—

F. E. STUART, President,
Stuart Corporation, Baltimore, Md.

Water Treatment Experiences

A well qualified chemist and superintendent of water treatment with varied experience and keen observation sets forth some of his "Experiences in Water Treament" in a series of articles, designed to be helpful to the less experienced and interesting to all. The author of this new series, which began in our January issue, is—

ALBERT H. ULLRICH, Supt.,
Water & Sewage Treatment, Austin, Tex.

Fundamentals of Sewage Chlorination

Are thoroughly reviewed and new ideas are presented in this paper by—

EDW. W. MOORE,
Assoc. Prof., Harvard University.

Practical Aspects of Sewage Chlorination

Are discussed in this review by—

L. F. WARRICK,
Chief State San. Engr., Madison, Wis.

Oxidation—Reduction Phenomena

Is receiving increasing attention by chemists and engineers concerned with sewage treatment and stream pollution by industrial wastes. To clarify the understanding of oxidation-reduction processes, and simplify the procedure of balancing oxidation-reduction equations, an improved method of doing such is offered by—

JEROME F. THOMAS,
Chemical Engr., Univ. of California.

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Water & Sewage Works is indexed regularly by Engineering Index, Inc.

Publication Office, 404 N. Wesley Ave., Mt. Morris, Ill.
(Address communications to the Executive Office or the Editorial Office)

EXECUTIVE OFFICE
22 W. Maple St., Chicago 10, Ill.

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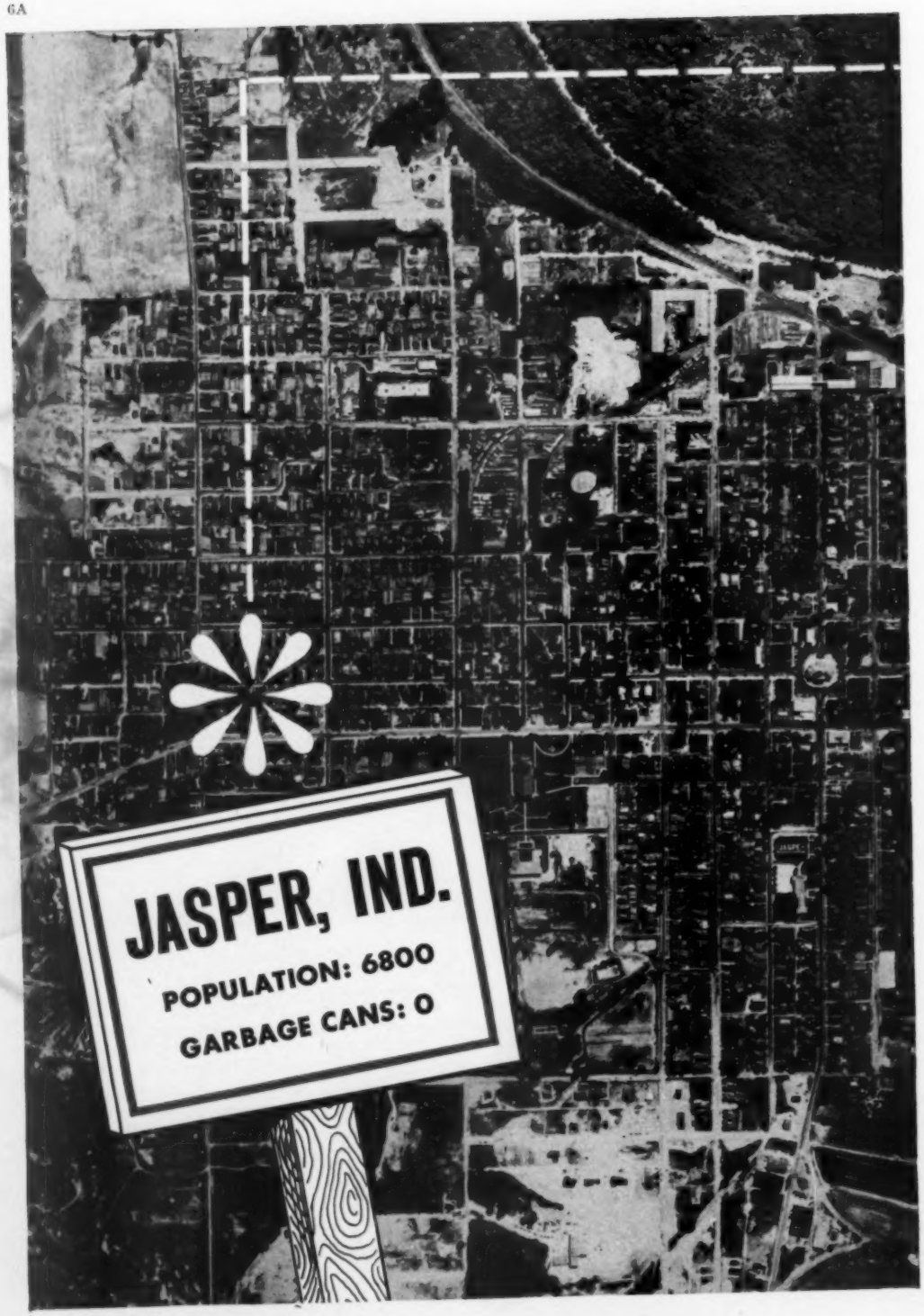
WATER AND SEWAGE WORKS is a monthly publication. Single Copies, 25c; Subscription Rates, U. S. and Canada, $2 per year; Foreign, $3.
(Member—Audit Bureau of Circulation and Associated Business Papers.)


JASPER, IND.
POPULATION: 6800
GARBAGE CANS: 0

It is happening here!

Sanitation history is in the making in Jasper, Indiana!

On August 1st, all garbage collection ceased. The Jasper Plan was in effect!

Over half the homes in this community were already equipped with electrical disposal units. G-E Disposalls® were shredding food waste into tiny bits—flushing it away to sewers and Jasper's new sewage plant. Garbage was *out* . . . Disposalls were in!

True, it may be months before the last bit of garbage disappears from Jasper—before "Garbage Cans—O"—*but it is happening here!* The day of a completely garbageless town is approaching *fast!*

General Electric is proud that its food-waste shredder—the G-E Disposall—was selected for the homes of Jasper. Proud that it was picked on the basis of over-all value—and performance in tough competitive tests, conducted by independent consulting engineers. BUT—

Credit for the success of the Jasper Plan must go to those who paved the way for this history-making event.

To the Indiana State Board of Health and B. A. Poole, State Sanitary Engineer who helped formulate and develop the new state law which allowed the Jasper Plan to be put into effect.

To Couch & Kulin, the consulting engineering firm which endorsed the use of garbage disposers, tested the competing units, and designed the city's sewage plant for dual disposal purposes.

To the City Council of Jasper and Mayor Thyen for blueprinting the plan and nursing it through every stage. And to the people of Jasper, themselves, who welcomed the plan and adopted it. *Jasper has a right to be proud of Jasper!* It has written a new page in sanitation history.

Behind the news headlines that told America about its first garbage-free city stand sanitation pioneers of cities all over the land.

These are the men who recognized the great benefits of the Disposall method of garbage elimination and made its adoption possible in their own communities. Jasper has proved the soundness of their thinking; but it was their careful deliberation and decisions that gave Jasper the confidence to take this revolutionary step forward.

The foresight of these great public officials—along with the concrete example that is now Jasper—is helping to speed the day when garbage will be a forgotten word in America.

Reminder to the FSWA!

Don't forget the meeting in Washington, D. C., October 9-12, Hotel Statler. And remember to stop in at the General Electric Exhibit. Our men will be happy to discuss Disposalls and dual waste disposal—and to show you the brand-new G-E Disposall!

The New General Electric Disposall shown installed in our Electric Sink. Food waste is scraped into drain opening and Twistop safety cover placed in position. Cold-water tap is then turned on, starting the Disposall operation. Food waste is shredded and flushed away automatically. General Electric Company, Bridgeport 2, Connecticut.

Disposall

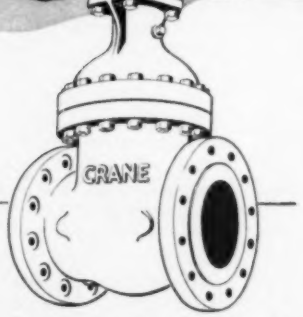
CONVERTS FOOD WASTE TO SEWAGE—ELIMINATES GARBAGE

GENERAL ELECTRIC

More **CRANE VALVES** are used than any other make

How CRANE controls quality to the Micro-Inch to cut your valve costs

Surface finish of a valve's working parts has a lot to do with its wear resistance and operating efficiency. A correct finish means a tighter-seating valve, easier operation, greater ease of maintenance. In Crane Quality valves, the surface finish of machined parts is measured and controlled to rigid limits. The standards for quality control of surface finish are determined by the most scientific methods as shown above. Yes, nothing is overlooked to make Crane Valves the lowest-cost valves in the long run. *That's Crane Quality!*



Precise quality control of materials, design, and manufacturing—to the highest degree in the industry—makes Crane valves the lowest cost valves in the long run. On steam service, oil and oil vapor lines, for example, you'll find Crane Steel Gate Valves a sure remedy for high maintenance costs. Talk it over with your Crane Representative.

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climax power

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Baton Rouge, Louisiana
Springfield, Massachusetts
Haverhill, Massachusetts
Holland, Michigan
Negaunee, Michigan
Benton Harbor, Michigan
Mankato, Minnesota
East Orange, New Jersey
New York, New York
Monticello, New York
Wilmington, North Carolina
Statesville, North Carolina
Concord, North Carolina
Carey, Ohio
Canal Winchester, Ohio
Amherst, Iowa
Akron, Ohio
Alliance, Ohio
Rockhill, South Carolina
Aberdeen, South Dakota
Ft. Worth, Texas
Provo, Utah
Antigo, Wisconsin
Oshkosh, Wisconsin
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Water Works: Climax engines provide dependable power to meet all emergency demands. Many of above installations have rendered reliable service over periods exceeding 15 years. Sizes 40 to 600 HP.

For complete information and service records of Climax Engines for Water and Sewage Works write to Climax Engine and Pump Mfg. Co., 208 S. La-Salle Street, Chicago, Illinois.

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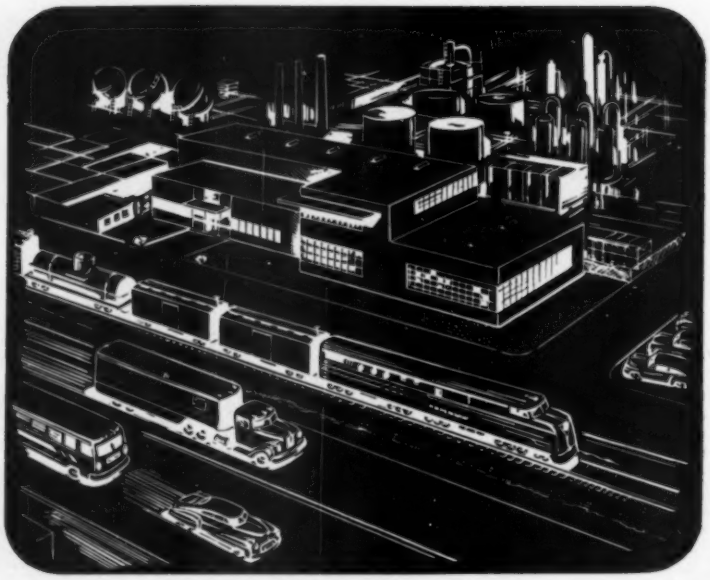
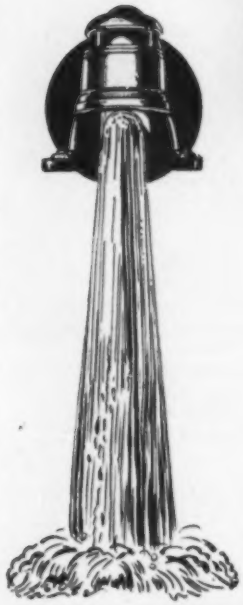
A new catalog on Layne Short Coupled Service Pumps with many diagrams showing applications, is now ready and will be sent upon request.





It Isn't A Question Of LEADERSHIP

Leadership in any field is a wonderful tribute to a fine product. But the Layne organization is anxious to have all prospective buyers consider the genuine quality of their Well Water Systems. Layne wants people to remember that their years and years of world-wide experience is being used to build better and better water systems; to find and remove even the smallest imperfection; to create, test and use new ideas that step up efficiency without adding cost.

Wherever you go, you will see Layne Well Water Systems serving cities, factories and all kinds of important industrial and chemical plants. In every case the buyer has carefully measured quality and efficiency against the investment and then decided that Layne and Layne alone could fulfill his needs.

A poor well is a bad investment. A good one saves many dollars each year. You can call in Layne and then contract for the complete job; survey, test drilling, drilling of the well, setting casing and sand screen, building and installing the pumps and final testing—all by well trained men of the Layne organization. No divided responsibility.

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LAYNE

WELL WATER SYSTEMS

VERTICAL *Turbine* PUMPS

Lithographed on stone by Edward A. Wilson

U.S. cast iron PIPE

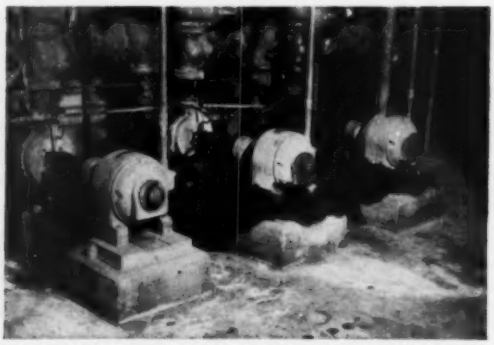
FOR WATER AND SEWERAGE AND INDUSTRIAL SERVICE

"Meet the customers' needs" has been our watchword for more than fifty years. Whether it's pipe seven feet, or a few inches, in diameter—or a complicated fitting—or a special casting—we have the equipment and the technical skills to meet almost any need for cast iron pressure pipe and fittings. Taking advantage of process developments and utilizing scientific methods to control quality, our plants are regularly manufacturing products that adequately meet our customers' exacting requirements. **United States Pipe and Foundry Co., General Offices: Burlington, N. J. Plants and Sales Offices Throughout U.S.A.**

CLEAN WATERS *at*

Airview of the Bird Island Sewage Treatment Works at Buffalo, N. Y. Treatment includes pumping, screening, aeration, chlorination, sedimentation, sludge digestion and incineration.

A G-E 7½-hp induction motor drives a sludge mixer. With their extra protection against physical damage, electrical breakdown and operating wear and tear, G-E motors assure long life and high service continuity.



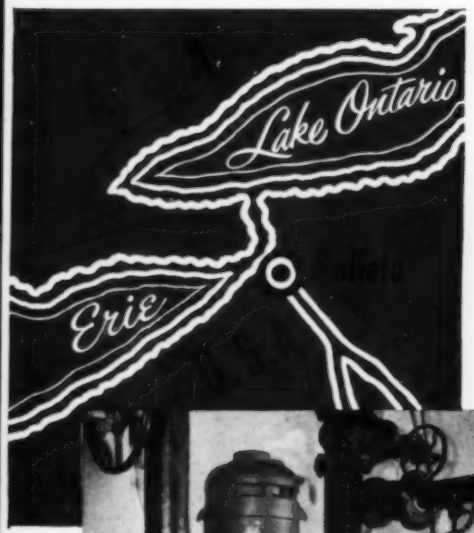
Three G-E 7½-hp splashproof induction motors drive filtrate pumps for vacuum filters. These motors have already given 12 years of service although constantly subjected to moisture from dripping and splashing.

GENERAL ELECTRIC

666-58

Buffalo HELP KEEP A TREATY

G-E Equipped Treatment Plant Guards International Waters

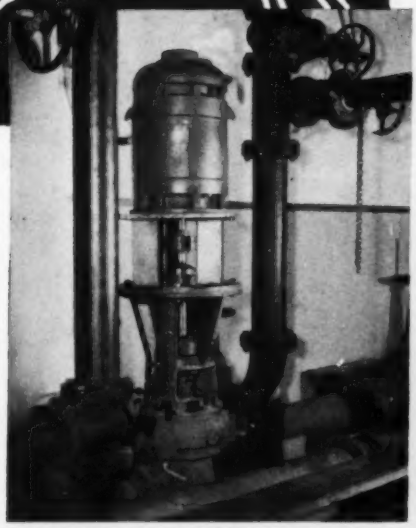


Since its dedication in 1938, Buffalo's sewage treatment plant has helped make good a U.S.–Canadian Treaty signed over 40 years ago to protect international waters from pollution. Located on Bird Island in the Niagara River, the plant has helped keep waters clean from Buffalo to Lake Ontario.

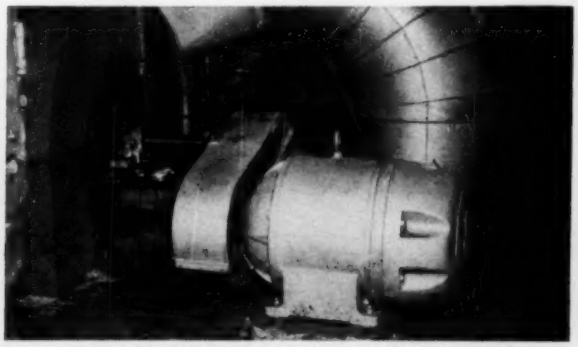
Plant officials attribute much of the success of the Buffalo plant's operation to the outstanding service given by some 100 General Electric motors. In many cases operating under the most severe conditions, the motors have given continuous and reliable performance.

General Electric can help your community get that new or improved sewage treatment plant by (1) assisting you and your consultant in formulating electrical plans, and (2) building public support through the use of G.E.'s full-color sound movie, *Clean Waters*.

Contact your General Electric representative early in the planning stage. *Apparatus Dept., General Electric Company, Schenectady, N. Y.*



Sludge circulating pumps for the digester tank are driven by G-E 10-hp vertical drip-proof motors. G-E vertical motors now have improved bearing lubrication and double-end ventilation for longer life and more efficient operation.



This is one of the G-E 50-hp, totally enclosed, fan-cooled induction motors used to drive exhaust fans for the sludge incinerator. The corrosive atmospheres in buildings like this call for motors that can take it.

GE SEWAGE-PLANT

Badger Meters solve city's water supply and financial problems

This city's demands for water were expanding. Two wells and the pumping facilities appeared inadequate. No overhead reservoir was available. Financing a third well and pumps was impractical. Water wastage (before installing Badger Meters) seemed excessive. The city decided to try metering as a means of reducing waste. Result: after metering, 24-hour flow was reduced over 55%. No new well needed. The water supply problem was solved . . . so was the financing problem! You, too, will find "It pays to BUY BADGER".

NEW! Badger Chart No. 695 (Practical plan for a small meter repair shop). WRITE today for this chart — no charge or obligation.

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You will find a Badger Meter size and type for every waterworks service. Shown here are Model SC-IOT (for warm climates), and Model A-IOT (for cold climates) . . . sizes ⅝" to 1¼" . . . other models in sizes up to 12". Write for complete information and prices.

BADGER Water METERS

ACCURACY • LOW-COST MAINTENANCE • DURABILITY • SENSITIVENESS

SEWAGE PLANT OPERATORS

For Clarification or Sludge Drying

INVESTIGATE THE ADVANTAGES

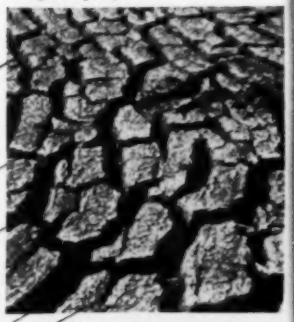
IN USING *GENERAL CHEMICAL* "ALUM"

Clarification

Above photograph illustrates effective coagulation and clarification of turbid waste by means of General Chemical Alum.

- *Clean and easy to handle*
- *Dry feeds well or dissolves readily for solution feeding*
- *Requires only low-cost feeding equipment and minimum attention*
- *Helps sludge digest readily*
- *Speeds sludge drying with minimum odor*
- *Produces clear, low-color effluents*
- *Reduces chlorine consumption in effluent*
- *Economical to use*

Sludge Drying



Above: Sludge bed treated with General Chemical Alum to hasten dewatering.

BASIC CHEMICALS

GC

FOR AMERICAN INDUSTRY

Wherever your plant may be—America over—you will find General Chemical "Alum" is always the same high quality . . . always uniform . . . always readily available from coast-to-coast producing and shipping points. To you, that means increased efficiency, stepped-up economy in your clarification and sludge drying operations. So be sure. Get the best; specify General Chemical "Alum"—the *preferred* "Alum."

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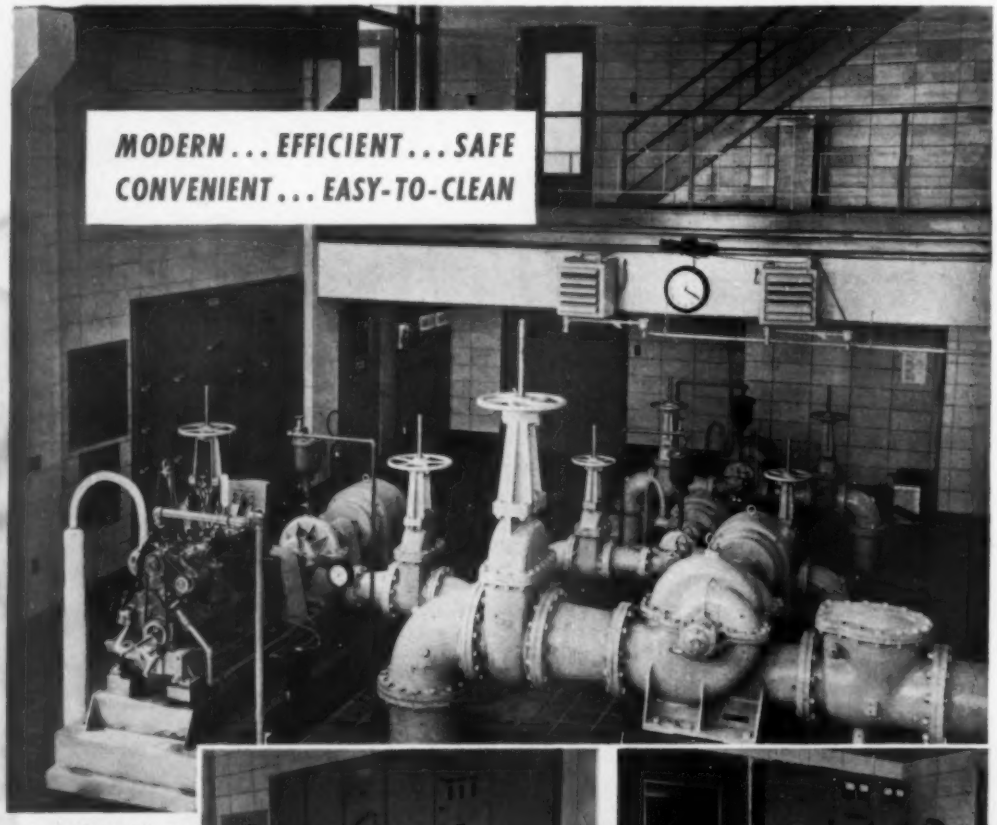
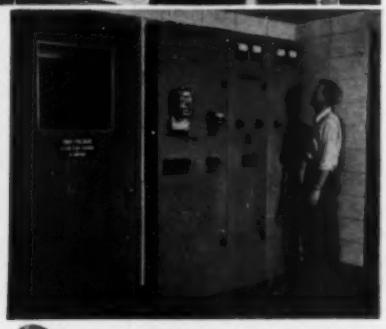
YOU CAN BE SURE.. IF IT'S
Westinghouse

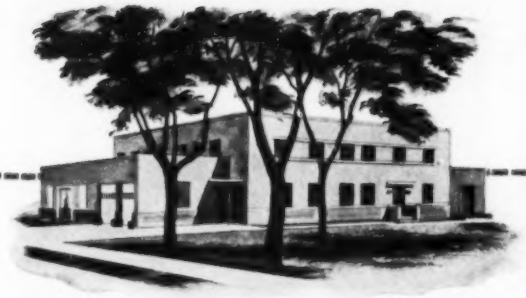


Engineers: Greeley & Hansen
Plant Supt.: Alvin G. Bares

1 **Control Center**—All plant operations can be controlled from this central power distribution unit. Steel cubicles hold switches, lights, pushbuttons and breakers. Bottom sockets for plug-in instruments permit load measurement on any individual circuit. Extra cubicles make future expansion easy.



2 **Incoming Switchgear Cubicles**—include switch for each of the incoming high-voltage lines—one for regular service and the other for emergency. Safe "dead-front" cubicles enclose all live apparatus. Shown here: Superintendent Bares checks his load. Watthour meters on his left record the power and lighting loads.



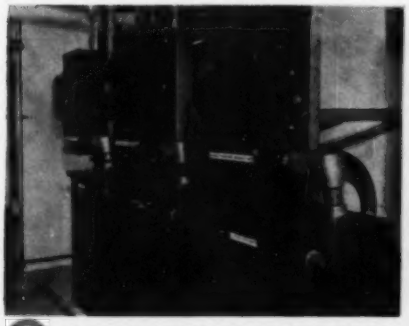
How one town invests in its future

It's not a *big* town but Port Washington, Wisconsin, is looking ahead! Their new pumping and filtration plant serves 5,000 people, taking 500 thousand gallons daily from Lake Michigan. Port Washington, typical of many towns, planned that this new investment should mean dependable service, flexibility for future expansion and reduced pumping costs for 30 or 40 years to come. *Your plant can realize these same advantages.*

The electrical control equipment at Port Washington is Westinghouse throughout. It is the latest, most efficient available today——the best guarantee that the plant will still be modern many years from now. Power is distributed and utilized at maximum efficiency. Safety is paramount—at no point are live parts exposed. All operations are supervised and controlled from one central point—with push-buttons on the working units for localized control when desirable.

Through long waterworks experience Westinghouse has learned how to co-ordinate electrical equipment to best meet the needs of *your particular operation.* And whether yours is a large plant or a small one, Westinghouse can supply everything electrical needed.

When you're planning to build or modernize, get in touch early with your near-by Westinghouse office. You'll make an investment in economical, efficient equipment that will be modern for years to come. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-94858



3 **Step-Down Transformers**—and other high-voltage power apparatus are enclosed in vault behind the wall formed by the control center, switchgear cubicles and locked door.

Westinghouse

EQUIPMENT FOR PUBLIC WORKS

SHOCK STRENGTH

Without shock strength—or, for that matter—without all of the strength factors listed opposite—no pipe laid 100 years ago in *city streets* would be in service today. But, in spite of the evolution of traffic from horse-drawn vehicles to heavy trucks and buses—and today's vast complexity of subway and underground utility services—cast iron gas and water mains, laid over a century ago, are serving in the streets of more than 30 cities in the United States and Canada. Such service records prove that cast iron pipe combines all the strength factors of long life with ample margins of safety. No pipe that is provably deficient in any of these strength factors should ever be laid in city streets. Cast Iron Pipe Research Association, Thos. F. Wolfe, Engineer, 122 So. Michigan Ave., Chicago 3.

CAST IRON PIPE

Strength factors of Long Life !

No pipe that is provably deficient in any of these strength factors should ever be laid in city streets

SHOCK STRENGTH

The toughness of cast iron pipe which enables it to withstand impact and traffic shocks, as well as the hazards in handling, is demonstrated by the Impact Test. While under hydrostatic pressure and the heavy blows from a 50 pound hammer, standard 6-inch cast iron pipe does not crack until the hammer is dropped 6 times *on the same spot* from progressively increased heights of 6 inches.

CRUSHING STRENGTH

The ability of cast iron pipe to withstand external loads imposed by heavy fill and unusual traffic loads is proved by the Ring Compression Test. Standard 6-inch cast iron pipe withstands a crushing weight of more than 14,000 lbs. per foot.

BEAM STRENGTH

When cast iron pipe is subjected to beam stress caused by soil settlement, or disturbance of soil by other utilities, or resting on an obstruction, tests prove that standard 6-inch cast iron pipe in 10-foot span sustains a load of 15,000 lbs.

BURSTING STRENGTH

In full length bursting tests standard 6-inch cast iron pipe withstands more than 2500 lbs. per square inch internal hydrostatic pressure, which proves ample ability to resist water-hammer or unusual working pressures.

SERVES FOR CENTURIES

MONO-CAST CENTRIFUGAL PIPE

For Water Works and Sewage Treatment Plants

The feeling of confidence that exists between the Acipco organization and that great body of men responsible for the development of water and sewage works in these United States is the result of many years of close cooperation. Since the beginning of our Company, Acipco has constantly worked hand in hand with engineers, contractors and superintendents in solving piping problems in their respective fields.

As always during the past, Acipco offers quality pipe and fittings plus experienced personal service.

Refer your next piping job to Acipco and utilize both our extensive manufacturing facilities and our nearly half a century of experience in furnishing pipe and fittings for water works and sewage disposal plants.

AMERICAN CAST IRON PIPE COMPANY

BIRMINGHAM 2, ALABAMA

Dallas Houston El Paso Pittsburgh Kansas City New York City
Chicago Minneapolis Cleveland Los Angeles San Francisco Seattle

How Prichard uses elevated storage

to help meet peak demands on water distribution system

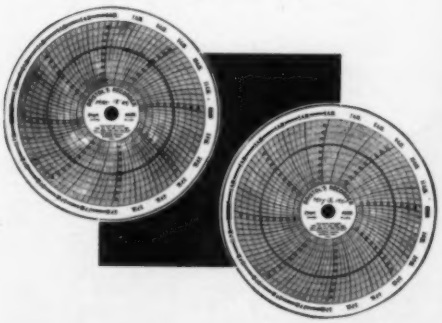
The maximum daily consumption of water in the city of Prichard, Alabama, is 3,700,000-gals. To help meet this peak demand, the city recently increased its total water storage capacity to 2,230,000 gals. by adding the 1,000,000-gal. Horton elevated tank shown at the right.

The reserve in this new tank flows into the system by the unfailing force of gravity during peak load periods. This means that the pumps can be operated at a relatively uniform rate which results in maximum pumping efficiency. By helping supply the additional water needed during high consumption periods, the Horton tank also reduced the pressure variation in the mains from 10 lbs. per sq. in. to 4 lbs.

In addition to supplying water for peak loads, Horton elevated tanks provide reserves for fire protection which often reduce insurance rates.

The radial-cone bottom design which is shown at the right is very popular for it provides large capacity without an excessive range in head. This design is built in standard capacities from 500,000 to 3,000,000 gallons. Write our nearest office for information or quotations.

Below: Charts showing how 1,000,000-gal. Horton tank reduced pressure variation in the water mains at Prichard, Alabama, from 10 lbs. per sq. in. (left) to only 4 lbs. (right).



Above: 1,000,000-gal. Horton radial-cone bottom elevated water tank at Prichard, Alabama. It has a range in head of 35 ft. This tank—like all our municipal installations—was built in accordance with the American Water Works Association specifications.

CHICAGO BRIDGE & IRON COMPANY

Atlanta 3.....2181 Healey Building
Birmingham 1.....1586 North Fiftieth Street
Boston 10.....1048—201 Devonshire Street
Chicago 4.....2198 McCormick Building
Cleveland 15.....2262 Guildhall Building
Detroit 26.....1551 Lafayette Building
Houston 2.....2115 National Standard Building
Havana.....402 Abreu Building
Los Angeles 17.....1555 General Petroleum Building
New York 6.....3390—165 Broadway Building
Philadelphia 3.....1644—1700 Walnut Street Building
Salt Lake City 4.....550 West 17th South Street
San Francisco 4.....1583—200 Bush Street
Seattle 1.....1350 Henry Building
Tulsa 3.....1646 Hunt Building

Plants in Birmingham, Chicago, Salt Lake City, and Greenville, Pa.

In Canada—Horton Steel Works, Limited, Fort Erie, Ont.

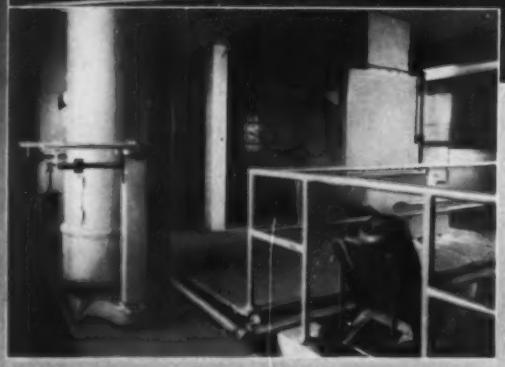
St. MARYS, OHIO

Water Softening Plant

(COMPLETED IN 1948)

FLOYD G. BROWNE & ASSOCIATES
Consulting Engineers
Marion, Ohio

BIRMINGHAM CONSTRUCTION CO.
Contractors
Birmingham, Michigan



Omega water works equipment furnished for the St. Marys Water Softening Plant:

1—Loss-in-Weight Type Gravimetric Feeder with lime slaker and weir box, extension hopper, and filling canopy for quick lime.

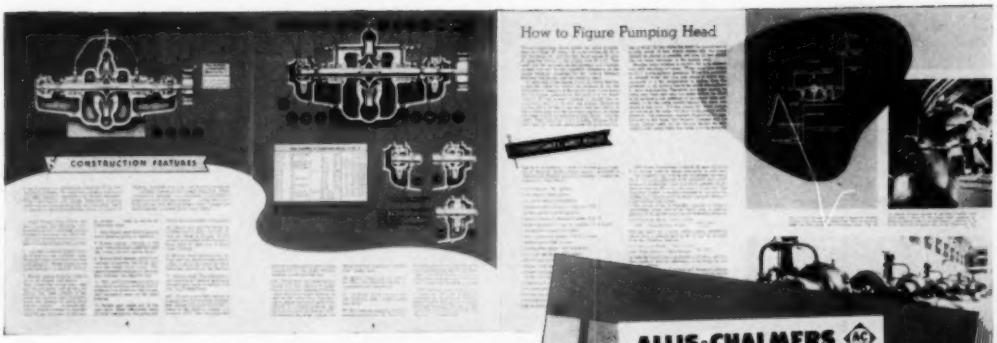
2—Universal Feeders with extension hoppers for feeding alum or soda ash.

While St. Marys, Ohio, is not a large city, its new water treating plant is designed to operate with all the efficiency and economy of a big municipal water works. The water softening process, in charge of Mr. R. E. Shoup, Superintendent, will save the 6,500 local water users thousands of dollars annually by reducing the amount of soap required for washing, by cutting down wasteful scale formation in pipes and boilers, and by eliminating harmful staining of plumbing fixtures.

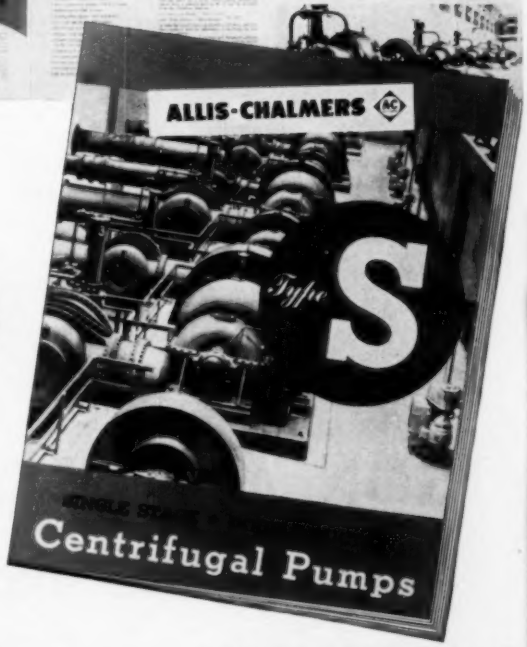
Engineered by Floyd E. Browne & Associates, and supervised during construction by Howard Palmer, Safety Service Director who was Resident Engineer, the new plant has the latest in chemical feeding and handling equipment.

An Omega Loss-in-Weight Gravimetric Lime Feeder and Slaker, equipped with extension hopper and filling canopy, supplies quick lime from the floor above, and has a large floor type weir box and agitator. Alum and soda ash are fed by Omega Universal Feeders which are mounted on scales to keep double check on the amount fed. For information and Bulletins, address Omega Machine Company (Division of Builders Iron Foundry), Providence 1, Rhode Island.

THE LAST WORD IN FEEDERS
OMEGA



How to Select and Apply Pumps



New Bulletin Gives Facts On —

- **How to figure pumping heads**
- **Tables of pipe friction losses**
- **7 pages of Head-Capacity tables**
- **Detailed cross-section drawings**

TWENTY FOUR PAGES packed with the kind of engineering data that you'll want to keep for your files . . . and it's yours for the asking!

Contains: detailed cross-section drawings of the latest Allis-Chalmers pumps . . . seven solid pages of head-capacity tables covering hundreds of pump sizes . . . rules and constants plus instructions for figuring pumping heads . . . two full pages of tables showing friction losses for water per 100 ft of pipe . . . and pages more of important pump facts.

Buy "A-C" For Equipment Coordination

You can get a more complete package of equipment from Allis-Chalmers and *know* where responsibility lies. For example, A-C can furnish pump, motor and control together — in a single package!

If your community is planning *any* public works improvements, call in your nearest A-C Sales Representative.

Texrope is an Allis-Chalmers trademark.

ALLIS-CHALMERS

SEND COUPON TODAY

ALLIS-CHALMERS, 1192A SO. 70 ST.
MILWAUKEE, WIS.

Please send me Bulletin 08B6146A, "Allis-Chalmers Type S, Single Stage, Double Suction Centrifugal Pumps."

Name.....

Company.....

Street.....

City.....

State.....

A-3078

World's Widest Range of Public Works Equipment

There are more ways than one to get rid of

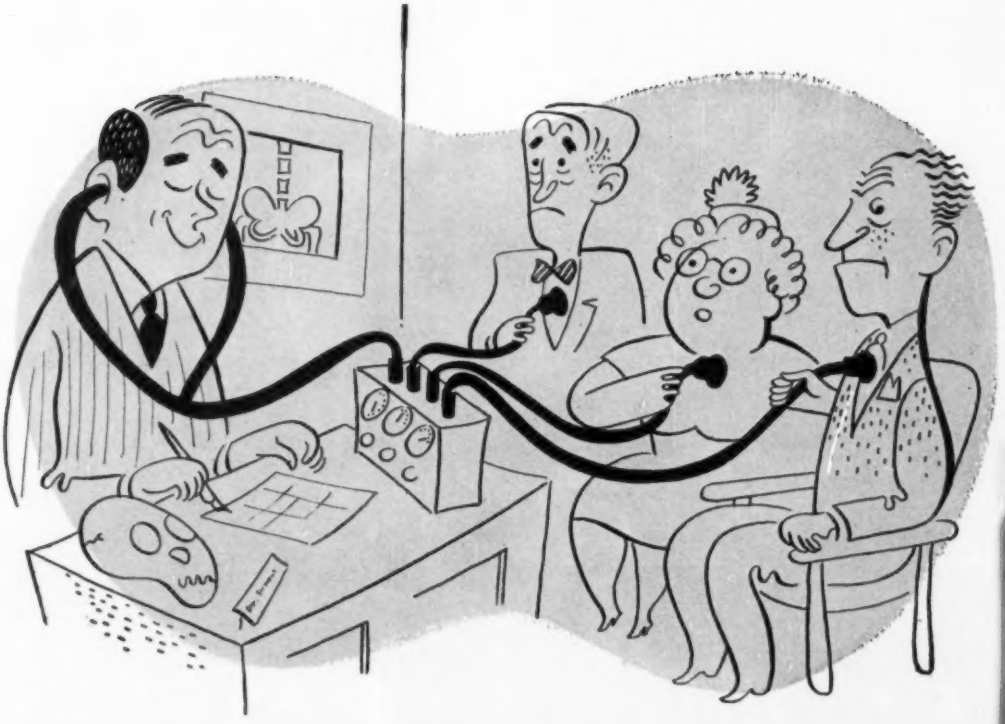
IRON AND MANGANESE

Iron and manganese are unpleasant impurities in water. They cause stains that interfere with industrial processes, and also make the water undesirable for household use.

Now Permutit's modern equipment eliminates these two water nuisances. You can remove iron and manganese in any of three ways: by base-exchange; by aeration, settling and filtration; or by oxidation through manganese zeolites. Find out which is best for your community . . . write for full information to The Permutit Company, Dept. W-10, 330 West 42nd Street, New York 18, N. Y., or to Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

Water Conditioning Headquarters for Over 37 Years

PERMUTIT



Reduced Treatment Costs

Less load at the disposal plant—and, therefore, a reduction in sewage treatment costs—is one of the practical advantages that often result from the use of Transite* Sewer Pipe.

There are two good reasons for this:

(1) Transite's special sleeve-type joints that cut sewer line infiltration to a minimum.

(2) Transite's long 13-foot lengths that reduce the number of joints in the line—an additional safeguard against infiltration.

Besides the immediate saving in treatment costs, this reduction in load also enables plant capacity to be conserved for future needs. And, where new treatment facilities are planned, it permits consideration of a smaller plant . . . with possible important economies in disposal equipment.

Other Transite Economies . . . Transite has an exceptionally smooth interior that reduces resistance to flow. This, combined with its long lengths that help maintain uniform grades, plus fewer joints that reduce turbulence, often permits designing the system with flatter grades and shallower trenches. Or, as an alternate economy, pipe of smaller diameter may be specified.

Transite Sewer Pipe is made of asbestos, cement and silica by a special method of manufacture which develops high, uniform strength and resistance to corrosion. It is available in four strength classes in sizes to 36". This permits selection of the pipe best suited to trench conditions, frequently eliminates the need for concrete cradles.

For further details, write Johns-Manville, Box 290, New York 16, N. Y.

JM

*Transite is a Johns-Manville registered trade mark

.....Johns-Manville

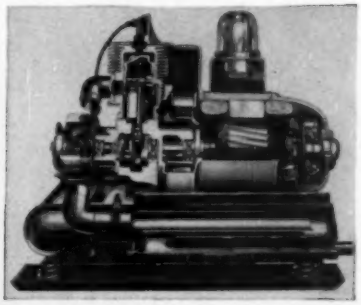
TRANSITE SEWER PIPE...

You Need All Three...You Get All Three

1. PERFORMANCE, 2. DEPENDABILITY, 3. SERVICE

HOMELITE *Carryable* GENERATOR

1. Performance. True, a Homelite Gasoline-Engine-Driven Generator is light enough for one man to pick up and carry but its performance is big enough to operate any electric tools or brilliant floodlights for night work. In fact, it gives you power *plus* . . . power plus a large overload capacity . . . power that isn't sapped by long dangerous cables. Easy to get on the job; quick to start at all times, never bothered by extreme temperatures, a Homelite is always ready with electric power in any emergency. It will save time and money for you on all jobs. Ask for a free demonstration and see for yourself.



2. Dependability. For more than 25 years, Homelite engineers have specialized in building carryable gasoline-engine-driven units. Their experience in building close to three hundred thousand of these units has been responsible for the simplicity of design and precision construction with finest materials that insure long-haul dependability and lowest maintenance costs.

3. Service. A Homelite seldom needs service, but when it does, there's a trained Homelite service man near you . . . a man who will drive his truck right out to your job and put your Homelite in perfect operating condition. This prompt, competent service is a great money saving factor for those who want to get continuous production out of their power tools.

STICK TO THE RULE OF THREE 1. Performance 2. Dependability 3. Service, and you'll always stick to a Homelite

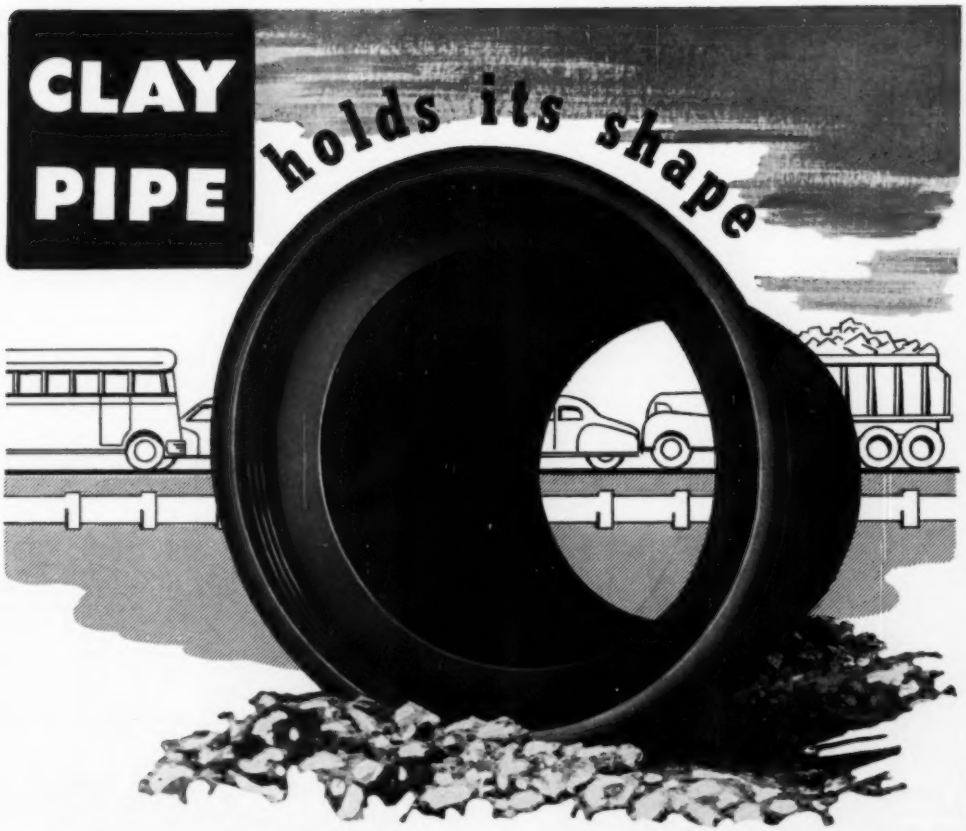
DEPENDABILITY PERFORMANCE SERVICE

HOMELITE CORPORATION

710 RIVERDALE AVENUE, PORT CHESTER, NEW YORK

MANUFACTURERS OF HOMELITE CARRYABLE PUMPS • GENERATORS • BLOWERS • CHAIN SAWS • PAVING BREAKERS

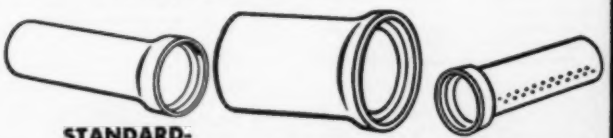
CLAY PIPE holds its shape



VITRIFIED CLAY PIPE is fired *hard* . . . it does not lose shape and flow capacity. Its rigidity keeps it round and smooth under the live or dead loads for which it is rated. Even under high temperatures, Clay Pipe holds its full inside diameter. It won't squash out — can't be cut or chewed by the rotary tools used to remove bulky obstructions from the line. In fact, Clay Pipe can't be affected by *any* of the common causes of sewer failure. It doesn't rust, corrode, melt, crumble, or disintegrate. Its permanent, trouble-free life doesn't depend upon sulphide control devices or the delicate balancing of such factors as sewage temperature, velocities and age of sewage. It's the *only* pipe built to withstand any operating conditions.

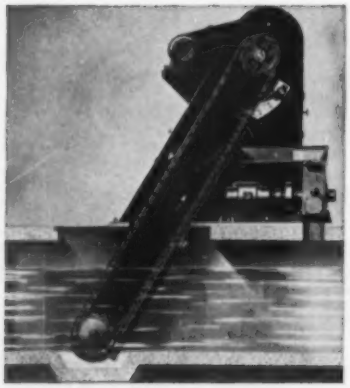
NATIONAL CLAY PIPE MANUFACTURERS, INC.
703 Ninth & Hill Bldg., Los Angeles 15, Calif.
100 N. LaSalle St., Rm. 2100, Chicago 2, Ill.
1105 Huntington Bank Bldg., Columbus 15, O.
206 Connally Building, Atlanta 3, Georgia

SPECIFY *Vitrified* **CLAY PIPE**



STANDARD-STRENGTH CLAY PIPE | **EXTRA-STRENGTH CLAY PIPE** | **PERFORATED CLAY PIPE**

0-4M-4



for the "BIGS" and the "smalls" REX provides *proved* equipment

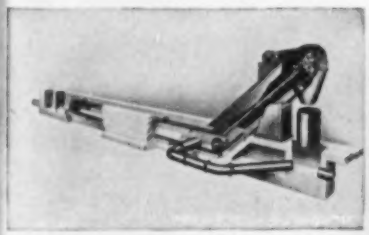
Large plant or small . . . primary or complete treatment . . . domestic or industrial waste, Rex Sanitation and Process Equipment is right for all.

Rex engineers consider the requirements of the small plant as well as the large . . . provide equipment that exactly suits the requirements. Equipment for the smaller plants is not just "scaled down" but is designed and built for the specific problems encountered. Conversely, large plant units are built for the job they must do.

Too, Rex answers the problem of the overloaded plant . . . offers equipment that can frequently expand existing capacities without enlargement of plant size.

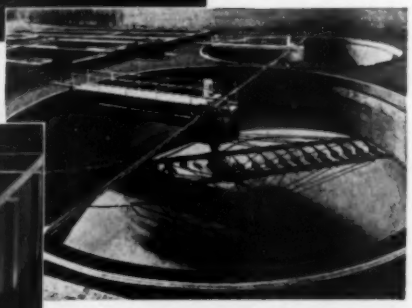
In any plant, Rex provides unequaled efficiency . . . capacity . . . sets the standards for economical, long-life operation. Specially trained Rex sanitation engineers will be happy to assist you with your individual problems. For complete information, write for your copy of Bulletin 48-41. Chain Belt Company, 1610 West Bruce Street, Milwaukee 4, Wisconsin.

REX MECHANICALLY CLEANED BAR SCREENS AND TRITURATORS are neat, streamlined units that provide an efficient means of removing large solids from liquids and reducing them in size. Reduced material is returned into the sewage flow for quick and efficient handling in settling tanks and digesters.

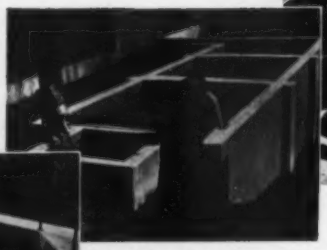


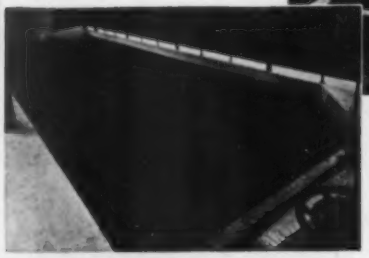
REX GRIT EQUIPMENT with its exclusive re-circulating principle, effectively separates and removes inorganic solids from liquids. No grit washer is required. Rugged construction assures long, economical service.

REX CONVEYOR SLUDGE COLLECTORS combine the well-known advantages of the rectangular settling tank with a rugged and efficient form of sludge removal mechanism. Whether handling primary sludge or light flocculent solids, their performance is efficient and economical.



REX SLO-MIXERS AND FLASH MIXERS assure rapid disbursement of chemical throughout the liquid, followed by a gentle, multi-stage slow mixing for optimum floc formation. Rex Slo-Mixers eliminate short-circuiting and effect savings in chemicals.





REX VERTI-FLO delivers a highly clarified effluent with an extremely short detention period. It provides maximum tank capacity for any desired tank size and maximum practical weir length. The combination of large weir length and low vertical velocities assures a clearer effluent, for greater capacity at minimum cost.

REX TOW-BRO SLUDGE COLLECTORS assure accurate control of sludge removal over a wide range of withdrawal rates through their exclusive suction principle. Sludge is removed immediately on contact instead of the usual plowing or scraping. Greater sludge concentration, greater operating flexibility, and a clearer effluent are a few of the many advantages.

CHAIN BELT REX COMPANY — SANITATION EQUIPMENT

HYDROCRANE

CUTS CATCH BASIN CLEANING COSTS 60%

for Milwaukee Sewer Department

FIGURES show that the Milwaukee Sewer Department has reduced catch basin cleaning costs by over 60 percent since switching from hand labor to a Bucyrus-Erie Hydrocrane. Equipped with an orange-peel type hydraulic catch basin cleaner, the department's Hydrocrane cleaned out an average of 30 catch basins per day — even under adverse winter conditions.

In addition to cutting costs, the Hydrocrane does a much better catch basin cleaning job. In fact, the entire operation is more sanitary because the crane loads directly to trucks, while hand laborers formerly piled the muck on the street first.

The Milwaukee Sewer Department also uses its Hydrocrane for excavating manholes, catch basins and trenches for storm overflow connections. Here the crane has reduced costs by 30 percent.

Find out how this versatile, fully hydraulic crane can save money on your sewer jobs. Two sizes — 2-ton ¼ yd.; 3-ton ⅜ yd. Send the coupon today.

BUCYRUS-ERIE HYDROCRANE DIVISION, South Milwaukee, Wisconsin

Here is the modern, sanitary way to clean catch basins. Notice the big load. This bucket removes dirt, stones, twigs, glass and other debris in short order.

BUCYRUS ERIE HYDROCRANE

BUCYRUS-ERIE HYDROCRANE DIVISION
South Milwaukee, Wisconsin

Gentlemen:
I want the full story on the Hydrocrane.

Name.....

Company or Dept.....

Address.....

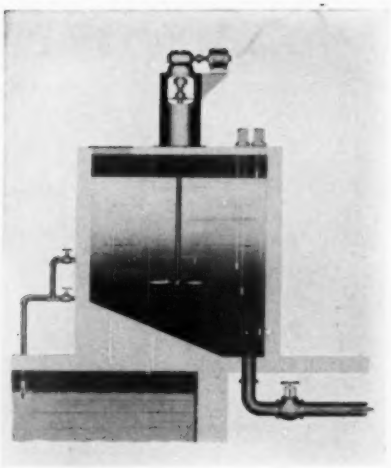
City.....

State.....

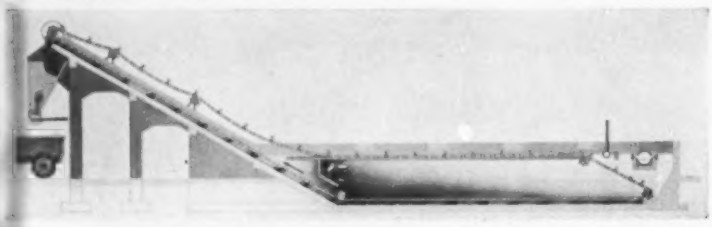
73H3D

Are INDUSTRIAL WASTES Your Problem?

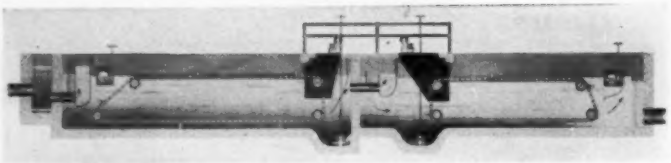
Let Link-Belt sanitary engineers show you how to recover valuable solids, protect public health, reduce stream pollution, and put waste treatment on an efficient basis. Link-Belt water and sewage treatment equipment is unexcelled in design and effective operation.



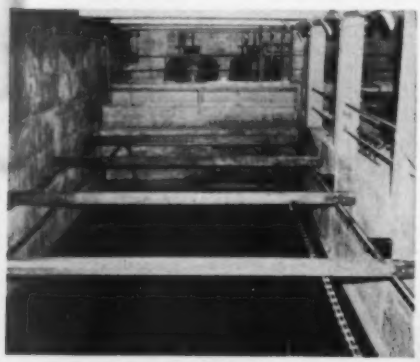
Above: Neutralization is accomplished by mixing lime with acid wastes in the Link-Belt Flash Mixer, which can also be used to treat metal plating wastes or wherever a rapid and thorough mixing of liquids and chemicals is desired.



Above: To prevent stream pollution, and recover valuable carbon, with low moisture content, and practically no hand labor, Link-Belt flight conveyor in a specially designed tank gives excellent results. Can also be used for removal of mill scale from cooling water, etc.



Above: To separate waste oil and heavy solids from refinery waste waters, Link-Belt Straightline oil and sludge collectors in specially designed tanks, give high efficiency, and conform to A.P.I. recommendations.



Above: Many Link-Belt Straightline sludge and grease collectors in catch basins at meat packing houses have paid their costs several times in value of grease and solids recovered. Grease is collected on water surface and solids are pushed along the floor of tank. Solids may be processed for protein animal food and grease recovered by rendering.

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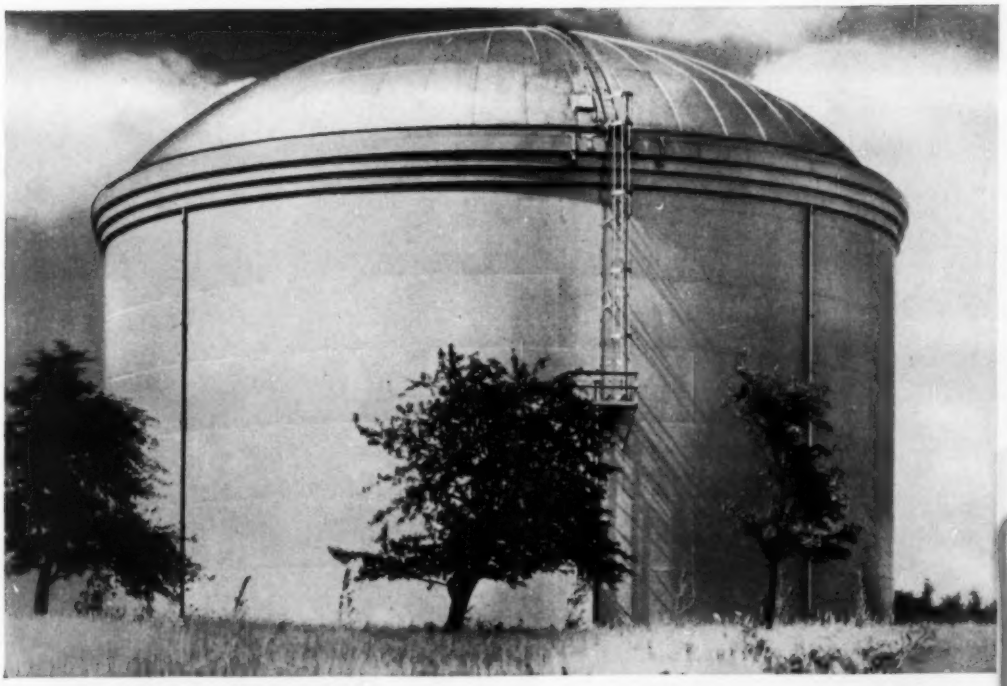

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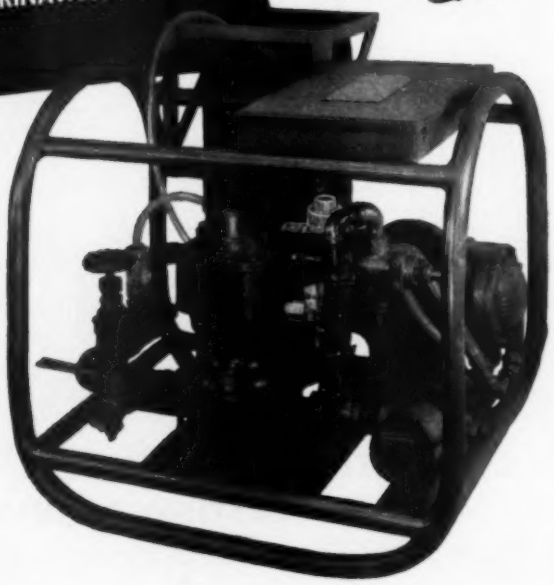
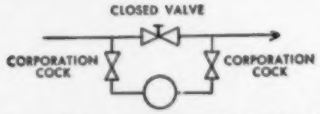
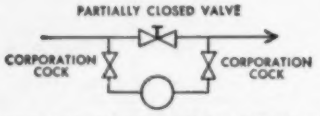




- **for use in by-pass around closed gate valve to chlorinate heavily for main sterilization.**



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%Proportioneers% new portable main sterilization unit is ready for work, any time, any place. Designed for emergency or general chlorination, this unit is light and compact — it can be easily carried wherever needed. It's a rugged, self-contained "package" — complete in every detail — including Chem-O-Feeder, Treet-O-Control meter, and chlorine solution tank with inter-connecting piping.

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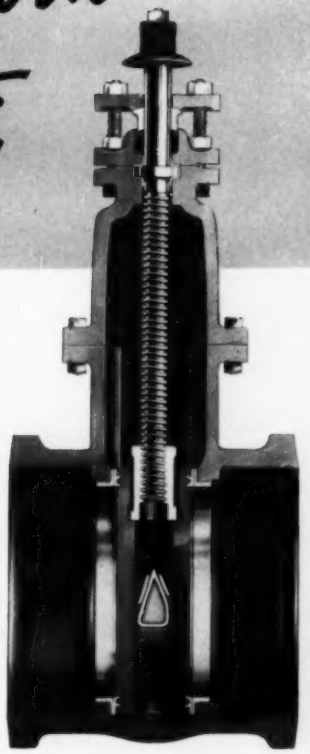
The very first turn OF THE VALVE STEM unlocks the gate



Yes—the FIRST turning movement of the valve stem unlocks the VALVE WEDGING mechanism, and relieves the wedge pressure from both gates of

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GATE VALVES

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Year	Tons Incinerated		Total Cost Operation & Maintenance	
	Dry Solids	Wet Cake	Per Ton Dry Solids	Per Ton Wet Cake*
1940	37,091	116,000	$1.36	$.436
1941	35,993	112,000	1.23	.394
1942	33,838	106,000	1.17	.375
1943	32,955	103,000	1.39	.445
1944	33,758	105,500	1.27	.407
1945	32,428	101,000	1.38	.442
1946	33,581	105,000	1.54	.493
1947	36,633	114,000	1.42	.455
1948	34,549	108,000	1.79	.573
1949	34,787	108,500	1.73	.554
Average	34,56.13	107,900	$1.43	$.457

*Based on average of 68% moisture in filter cake

When increasing population requirements necessitated additional incinerator capacity, the Nichols Multiple Hearth Furnace was again selected. This fourth unit will be in operation shortly.

The operation costs shown in the table* include all salaries, wages, materials, supplies, power, light, water and miscellaneous charges. Also accounted for are all labor costs and materials required for maintenance of the sludge incinerator equipment.

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**Figures taken from Annual Reports of Minneapolis-St. Paul Sanitary District 1940-1949.*

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Particularly important is the wide range of factory-sealed, maintenance-free Beckman Glass Electrodes available for use with this instrument . . . electrodes that are virtually unbreakable . . . that cover extreme temperature ranges from below freezing to above boiling . . . that have an unprecedented pH range with negligible errors . . . that are abrasion-resistant and chemically durable to a degree never before thought possible in glass electrodes.

*In addition to the H-2 Meter, other Beckman pH equipment includes completely automatic pH indication and control instruments for large-scale process applications . . . battery-operated models for complete portability in plant and field use . . . and a laboratory type instrument that features maximum versatility and accuracy for research and laboratory applications

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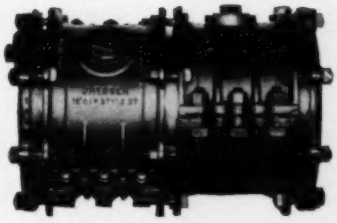

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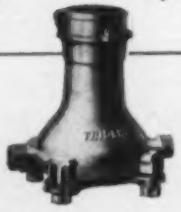

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WATER & SEWAGE WORKS

Vol. 97, No. 10 OCTOBER, 1950

A Gillette Publication

GRAPHICAL APPROACH TO STATISTICS

Part III—Use of Skewed Probability Paper*

by

C. J. VELZ

Chairman
Dept. of Public Health Statistics
School of Public Health
UNIVERSITY OF MICHIGAN

THIS article will deal with skewed probability paper as applied to series of extreme values such as floods, droughts, or storm rainfall intensities. It is well known that extremes of hydrologic phenomena such as floods and droughts do not follow a normal symmetrical distribution, but rather are skewed (the more severe values deviate beyond the mean to a much greater extent than the less severe values deviate below it). Gumbel** developed a standard skewed distribution based upon the theory of largest values which when reduced to straight line form on special probability paper as suggested by Powell†, simplifies and facilitates the graphical solution of many statistical problems dealing with series of extreme values.

A comparison of the normal probability curve and Gumbel's standard skewed distribution of largest values is shown on Fig. 9. On Fig. 9 (a) is the normal probability curve, which is perfectly symmetrical, with the mean and mode coinciding at the midpoint. Fig. 9 (b) is Gumbel's skewed distribution, which is asymmetrical, rising sharply to the peak and then falling off gradually in a long tail to the right, with the mode to the left of the mean. As with the normal curve, the probability of events is represented by the area under segments of the curve, total area being unity or 100 per cent. Gumbel has given these areas for increments of the curve and by summing from left to right a probability summation scale is obtained for the skewed distribution similar to that developed in the preceding article for normal probability paper.

The Author

The proper evaluation of data in sewage works operation and stream pollution studies cannot be accomplished by simple mathematical averages of a series of analytical results. "Statistical evaluation offers the only means of condensing raw data to concise form, permitting significant interpretation," according to the author. This series of articles on the "Graphical Approach to Statistics," has been prepared especially for *Water & Sewage Works* to show how the usual forbidding methods of statistics can be used by means of graphic solutions. These articles may well revolutionize future work in this field with particular reference to water and sewage analysis for chemical and bacteriological constituents. —The Editors.

Fig. 10 shows such a probability summation arranged to form a standard skewed probability paper applicable to series of extreme values. The ordinate (Y) is a linear scale assigned to the observed extreme values. Scale X is the probability summation scale giving the probability of a value *equal to or less than* a certain value Y. The X′ scale is introduced for linearity and as an aid in fitting a straight line, which will be illustrated later. T_x scale at the top, "Return Period," is the probability of a value equal to or greater than. If the observations are equally spaced in time and the unit of time is taken as the interval between two successive observations, the Return Period, T_x, is defined as the mean number of observations, or average time, necessary to obtain once a value equal to or greater than a certain value Y.

$$T_x = \left(\frac{1}{1-X}\right)$$

Maximum Series

Gumbel's skewed probability paper is applicable to series of minimum values as well as maximum values providing the data are arranged in order of severity rather than magnitude, starting with the least severe value and ending with the most severe. In dealing with maximum series, such as floods, the least severe value would be the smallest observed flood, and the most severe value

*Other articles in this series appeared in the May and August issues

**Gumbel, E. J. "The Return Period of Flood Flows," Annals of Mathematical Statistics, *12*, 163 (1941)

†Powell, R. W. "A Simple Method of Estimating Flood Frequencies," Civil Engineering, *13*:105 (1943)

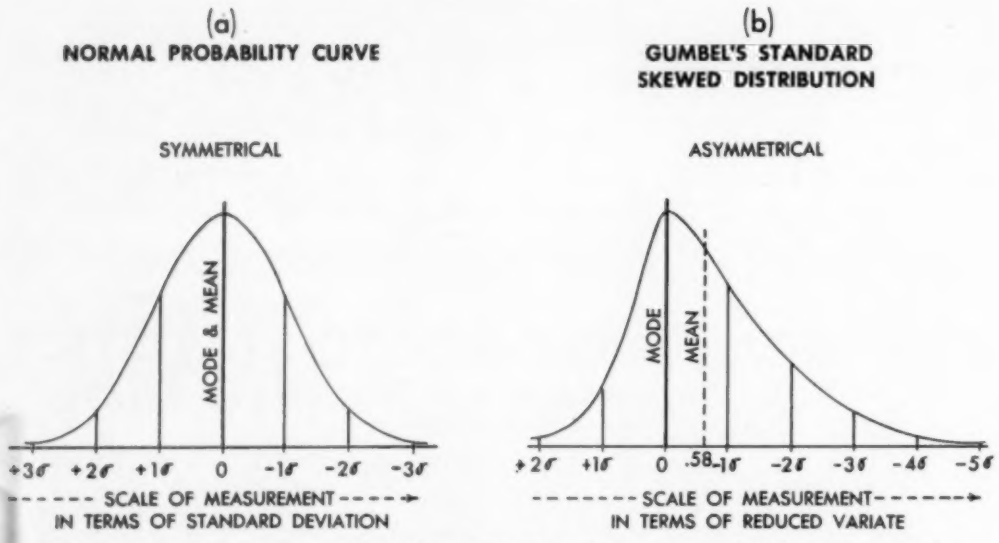


Fig. 9—Comparison of the Normal Probability Curve and Gumbel's Standard Skewed Distribution of Largest Values

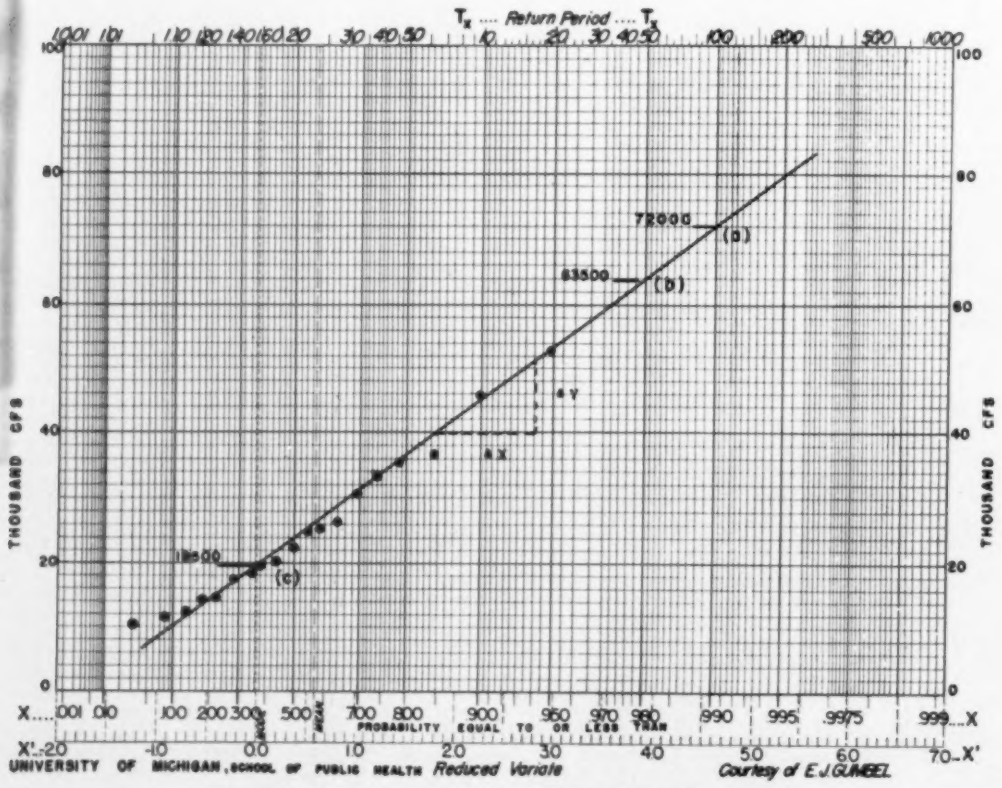


Fig. 10—Probability Annual Flood Discharge Clark Fork Below Missoula, Mont.

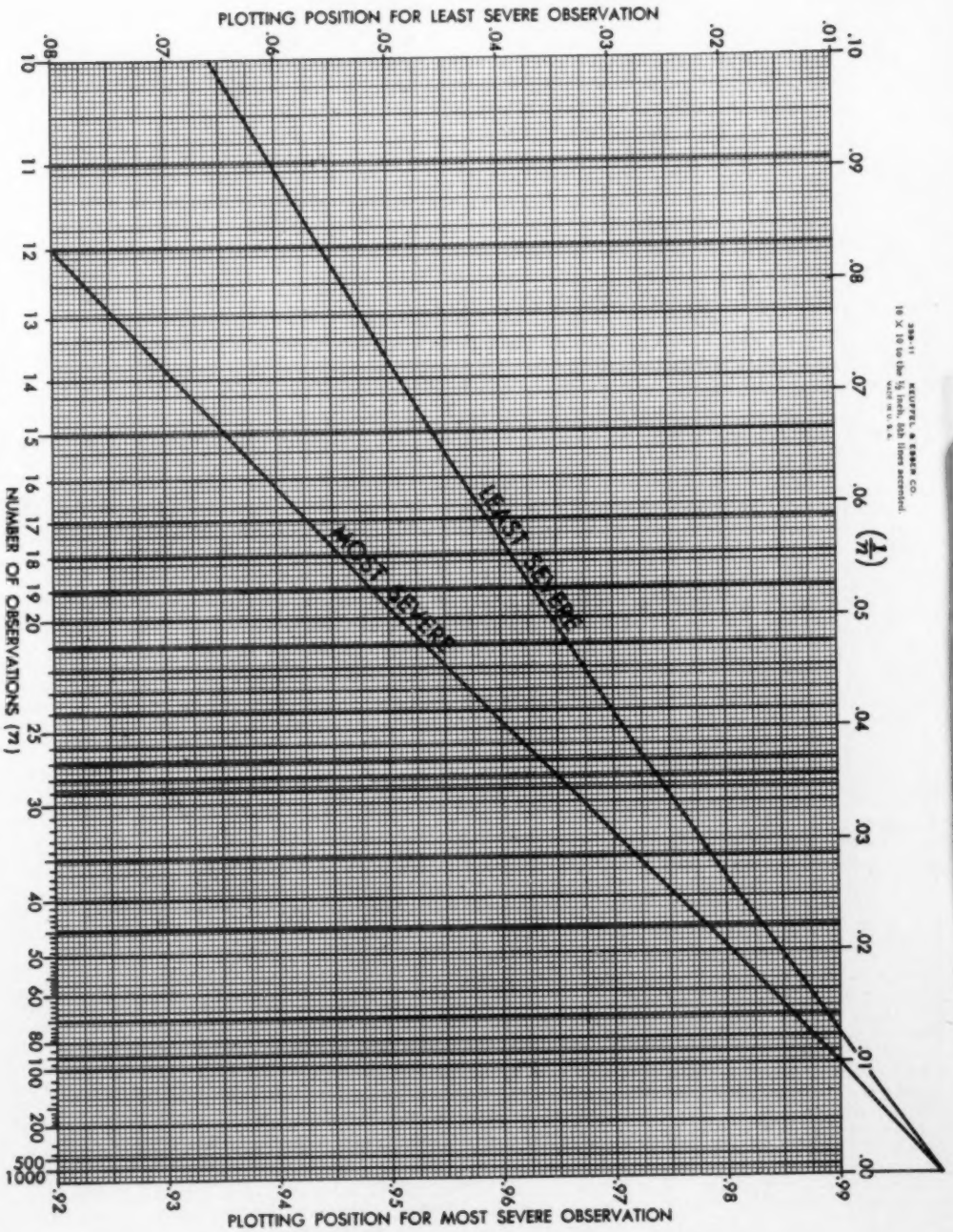

PLOTTING POSITION FOR LEAST SEVERE OBSERVATION
.08 .07 .06 .05 .04 .03 .02 .01 .10
.09 .08 .07 .06 (1/2) .05 .04 .03 .02 .01 .00
NUMBER OF OBSERVATIONS (n)
10 11 12 13 14 15 16 17 18 19 20 25 30 40 50 60 80 100 200 500 1000
LEAST SEVERE
MOST SEVERE
.92 .93 .94 .95 .96 .97 .98 .99
PLOTTING POSITION FOR MOST SEVERE OBSERVATION

Fig. 11—Plotting Positions for the Least Severe and the Most Severe of any Number of Observations for a series of Either Maximum or Minimum Data

(According to Gumbel)

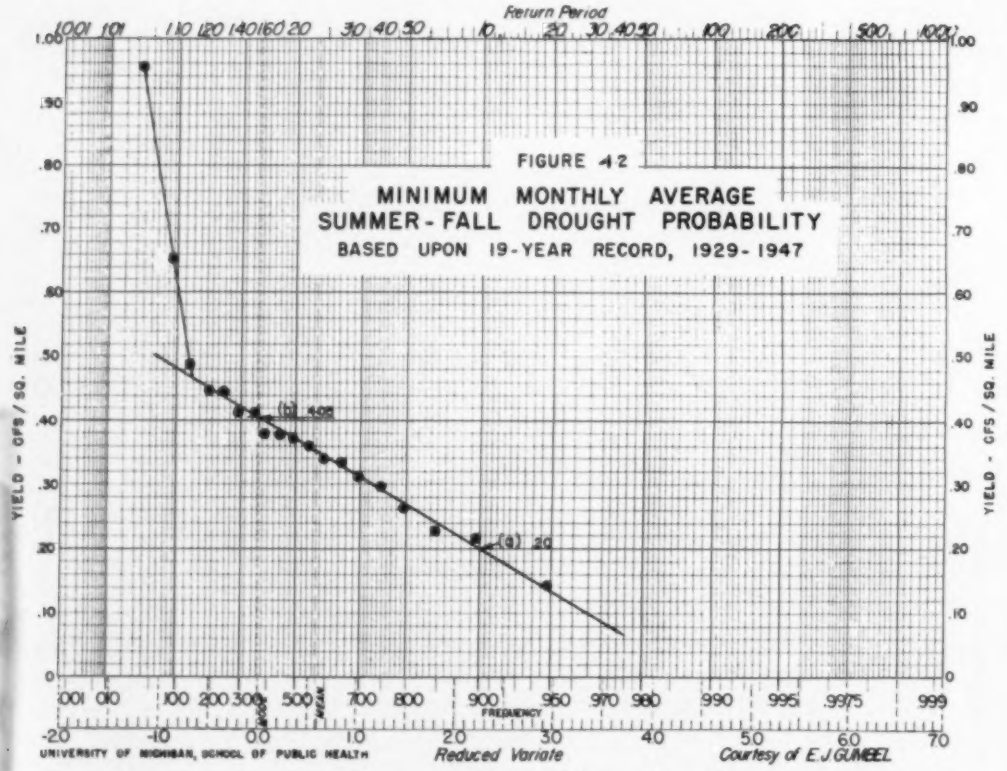


Fig. 12—Minimum Monthly Average Summer-Fall Drought Probability
(Based upon 19-year record, 1929-47.)

would be the largest observed flood. However, in dealing with minimum data, such as droughts expressed in cfs, the least severe drought would be the largest cfs among the observed droughts and the most severe drought would be the smallest cfs among the observed values, just the reverse of floods. This places the most severe flood and the most severe drought in the same position in terms of probability of severity. Thus by the simple technique of arranging maximum or minimum data in order of *severity* we place them in order of their position on the probability summation scale of the skewed probability paper.

Series of data that are truly extreme values will plot as a straight line on the skewed probability paper which facilitates interpolation and extrapolation. From such a straight line, probability of any severity can readily be determined graphically.

The Plotting Position

In the previous article the problem of the plotting position on the probability summation scale was discussed recommending $m/(n+1)$. This simple relation may also be employed for series of extreme values where m is now the serial number of data arranged in order of severity and n is the total number of values to be plotted.

Gumbel, however, has suggested a refinement which is recommended especially when dealing with a small series of say less than 20 observations. He develops the probability of the most probable least severe and most probable most severe value as the plotting position of the two extreme observations m_1 and m_n; and calculates the remaining (n-2) plotting positions by dividing the intervening interval into (n-1) equal units.

The plotting position for the least severe and the most severe values are complex functions of n, the number of observations, and for convenience may be read directly from Fig. 11. Only slight difference in the straight line plot on the skewed probability paper results between plotting positions determined from $m/(n+1)$ or from Gumbel's refinement, except with a small number of observations.

Plotting Series of Extreme Values

In summary, the procedure for plotting series of extreme values, maximum or minimum, on skewed probability paper is as follows:

1. Arrange the data in order of severity commencing with the least severe.
2. Assign a serial number "m" to each of the n values, 1, 2, 3, . . . n.
3. Compute the plotting position of each serial value, giving the probability equal to less severe than, for each value either by $m/(n+1)$ or by Gumbel's refinement.
4. Plot the points. The scale by which the observed measurements were made is laid off on the linear Y-axis; the computed plotting positions are the probability summation scale on the X-axis.
5. If a straight line is indicated by the plotted points it may be sketched graphically or it may be fitted by more precise means. Usually a

graphical sketching is adequate.

The procedure and interpretations are best illustrated by specific applications which follow.

Flood Data

For purposes of illustrating a series of maximum values, the annual flood,* the highest peak discharge in each water year, is used. Table 3 represents such a series for Clark Fork below Missoula, Mont., drainage area 8,690 square miles, for the period 1930-1948. The plotting positions of Column 5 are in accordance with Gumbel's refinement obtained as follows:

Position of the most severe flood obtained from most severe curve, Fig. 11 ..... .9485

Position for the least severe flood read from least severe curve. Fig. 11 ..... .0373

Interval between least severe and most severe ..... .9112

Increment for successive points $\frac{.9112}{(19-1)}$ ..... .050622

*Annual one-day flood, largest 24-hour average discharge among 365 days of each year, also develops a series of maximum values.

Table 3

MAXIMUM ANNUAL FLOOD

Highest Peak Discharge In Each Water Year

Clark Fork Below Missoula, Mont.

Year	Discharge c.f.s.	Floods Arranged in order of Severity (Y)	Serial Number	Plotting Position (X)
(1)	(2)	(3)	(4)	(5)
1930	17,500	10,400	1	.0373
1931	12,200	11,700	2	.0879
1932	25,000	12,200	3	.1385
1933	36,800	14,200	4	.1892
1934	25,700	14,400	5	.2398
1935	20,200	17,500	6	.2904
1936	26,700	19,100	7	.3410
1937	11,700	19,700	8	.3917
1938	35,700	20,200	9	.4423
1939	22,000	22,000	10	.4929
1940	14,200	25,000	11	.5435
1941	10,400	25,700	12	.5941
1942	30,500	26,700	13	.6448
1943	33,200	30,500	14	.6954
1944	14,400	33,200	15	.7460
1945	19,100	35,700	16	.7966
1946	19,700	36,800	17	.8473
1947	45,900	45,900	18	.8979
1948	52,800	52,800	19	.9485

Thus the position of the least severe flood is at .0373, the second least severe flood at (.0373+.0506) or .0879, the third least severe at (.0879 +.0506) or .1385, etc., adding .0506 for each successive value until the 19th or most severe value is reached with a plotting position .9485.

Column 3 and Column 5 of Table 3 provide the coordinates for plotting the data on skewed probability paper as shown on Fig. 10. A straight line is indicated as represented by the solid line fitted through the data. Thus, the 19-year record, while short, is in accord with the theory of ex-

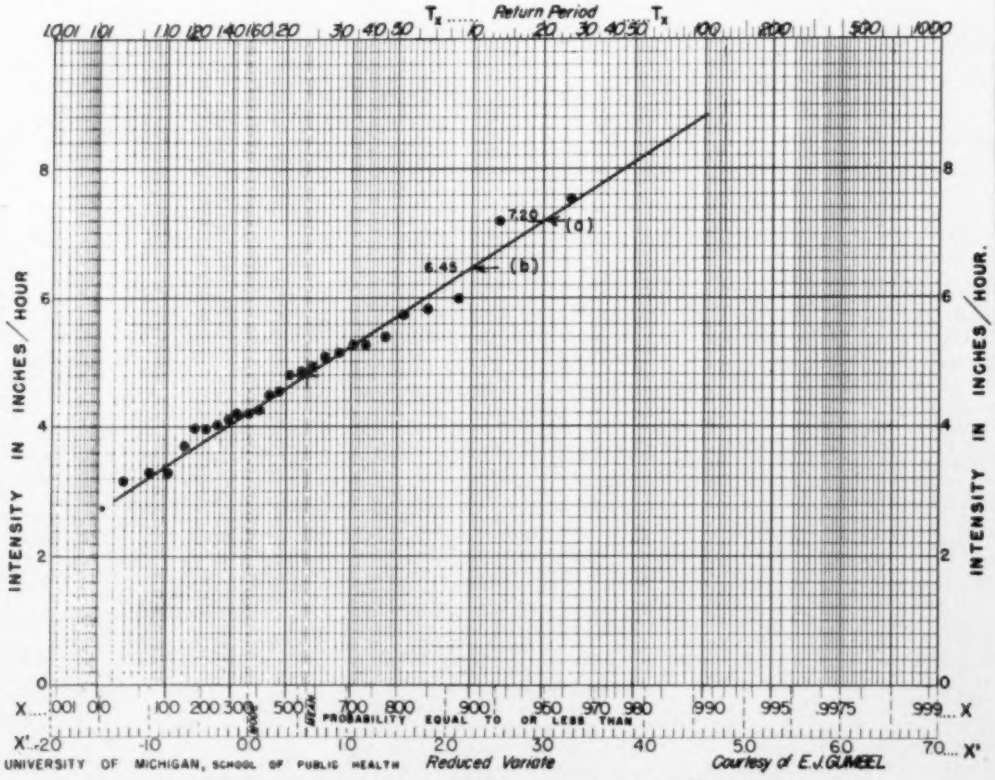

Return Period
Tx
1.001 1.01 1.10 1.20 1.40 1.60 2.0 3.0 4.0 5.0 10 20 30 40 50 100 200 500 1000
INTENSITY IN INCHES/HOUR
7.20
(a)
6.45
(b)
X .001 .01 .100 200 300 500 700 800 900 950 970 980 990 995 .9975 .999 X
PROBABILITY EQUAL TO OR LESS THAN
X' -2.0 -1.0 0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 X'
Reduced Variate
UNIVERSITY OF MICHIGAN, SCHOOL OF PUBLIC HEALTH
Courtesy of E.J. GUMBEL

Fig. 13—Probability Maximum Storm Rainfall Intensity for 10 Minute Duration, New York City

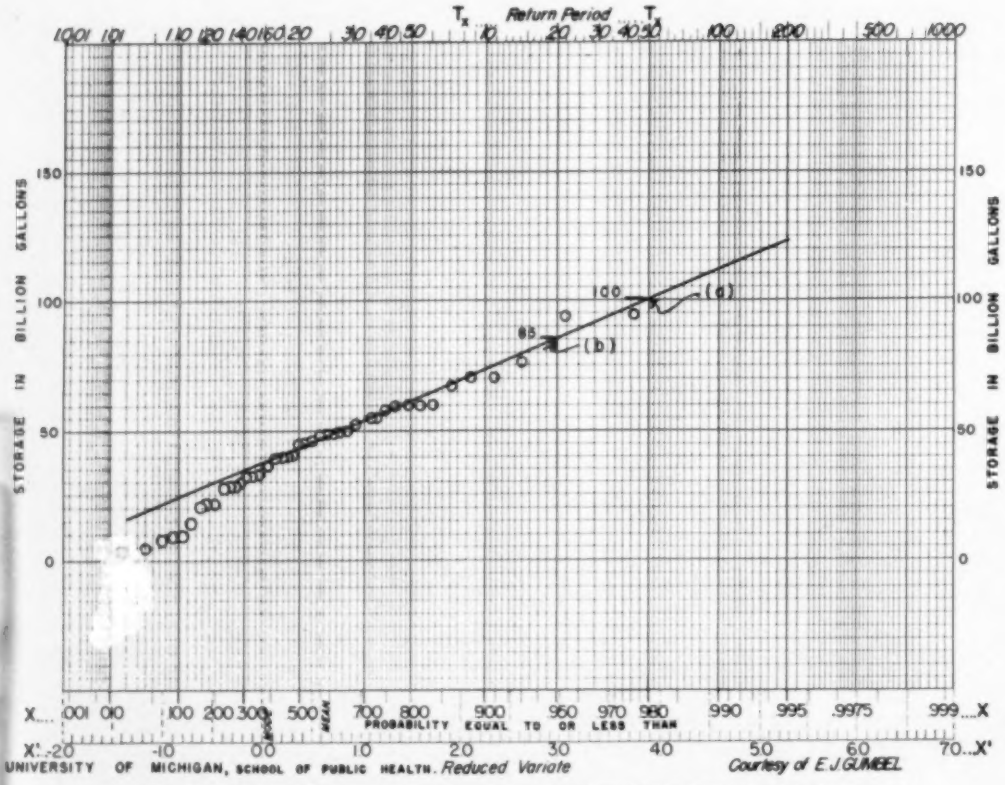


Fig. 14—Probability Maximum Storage Requirements for Water Supply Demand of 500 MGD.
(Schoharie-Esopus Basin, 671 sq. mi.)

treme values and the fitted line may be accepted as a representative sample of flood expectancy for this river and probability of flood severity may be read directly from the line extrapolated beyond the record.

Since the mean return period interval between observations is a year, it is customary to speak of flood severity as equaled or exceeded in the long-run on the average once in 100 years as the 100-year flood. For the Club Fork the 100-year flood is located by extending vertically from 100 on the T_x scale to intersect the distribution line at (a), reading on the Y-scale 72,000 cfs. Similarly, in the long-run on the average once in 50 years a flood of 63,500 cfs. or greater may be expected, located at (b). The most probable flood value expected in any year is located where the mode cuts the distribution line, in this instance at (c) as 19,500 cfs.

The slope of the line on skewed probability paper is a measure of the degree of variation among the annual flood values. This slope may be obtained graphically by scaling any $\frac{\Delta Y}{\Delta X'}$ developed by the distribution line, employing the reduced variate scale for $\Delta X'$. If the flood flows are expressed in yields, cfs. per square mile of tributary drainage area, slopes for flood distributions for different drainage areas are directly comparable. In this example $\frac{\Delta Y}{\Delta X'} =$ 11,400 in terms of cfs., or 1.31 in terms of yield. In a similar manner, if the Most Probable Flood (located by the Mode, X′=O) is also expressed as a yield, cfs. per square mile of tributary drainage area (in this example 19,500/8,690 or 2.245), a comparative measure of flood potential is obtained. The slope and the Most Probable Flood (MPF) expressed in terms of yield are two significant indices for comparative study of flood characteristics. These indices also afford an excellent summary, as the complete distribution line can be reconstructed simply by locating the MPF on the modal line and from this point lay off the slope and draw the distribution line.

Drought Data

For purposes of developing a series of minimum values, minimum monthly* average drought flows occurring during the summer-fall period, May through November, of each year have been selected from the runoff records of the Ocmulgee River at Macon, Ga. (drainage area 2,240 square miles) as shown in Table 4. In this illustration, runoff is expressed as yield, cfs. per square mile. The plotting positions in Column 3 are in accord with Gumbel's refinement and are obtained in the same manner as previously illustrated for floods. Using as coordinates the minimum monthly drought flows of Column 1 and corresponding plotting positions in Column 3 the droughts are plotted as shown in Fig. 12.

*Minimum daily average or minimum weekly average discharge data also develop series of minimum extreme values.

Table 4
MINIMUM MONTHLY AVERAGE DROUGHT
Summer-Fall Period,
May Through November
Ocmulgee River at Macon, Ga.

CFS. Per Sq. Mi. in order of Magnitude (Y) (1)	Serial Number (2)	Plotting Position (X) (3)
.954	1	.0373
.650	2	.0879
.485	3	.1385
.447	4	.1892
.446	5	.2398
.412	6	.2904
.412	7	.3410
.380	8	.3917
.377	9	.4423
.374	10	.4929
.360	11	.5435
.340	12	.5941
.335	13	.6448
.314	14	.6954
.298	15	.7460
.264	16	.7966
.228	17	.8473
.218	18	.8979
.114	19	.9485

Table 5
MAXIMUM STORM RAINFALL INTENSITY FOR 10 MINUTE DURATION
NEW YORK CITY

Year (1)	10 Min. Duration Inches/Hr. (2)	10 Min. Duration in order of Magnitude (Y) (3)	Serial Number (4)	Plotting Position (X) (5)
1895	3.96	3.18	1	0.0282
1896	5.10	3.30	2	.0656
1897	3.72	3.30	3	.1029
1898	3.18	3.72	4	.1403
1899	4.20	3.96	5	.1777
1900	3.30	3.96	6	.2150
1901	4.92	4.02	7	.2524
1902	5.16	4.14	8	.2897
1903	4.14	4.20	9	.3271
1904	4.86	4.20	10	.3645
1905	7.56	4.26	11	.4018
1906	5.82	4.50	12	.4392
1907	3.96	4.56	13	.4766
1908	3.30	4.80	14	.5139
1909	5.28	4.86	15	.5513
1910	6.00	4.92	16	.5887
1911	4.56	5.10	17	.6260
1912	5.28	5.16	18	.6634
1913	7.20	5.28	19	.7008
1914	4.80	5.28	20	.7381
1915	5.40	5.40	21	.7755
1916	4.50	5.76	22	.8128
1917	5.76	5.82	23	.8502
1918	4.02	6.00	24	.8876
1919	4.20	7.20	25	.9249
1920	4.26	7.56	26	.9623

Since data are arranged in order of severity, it will be noted that the distribution slopes downward. Another characteristic of drought distributions commonly encountered is the sharp break in the distribution line taking place at the left of the mode. Such a break formed by the less severe values to the left of the mode may be regarded as defining when the flow is no longer a drought and is blending back into the normal runoff. Our interest lies in the distribution of the true droughts to the right of the mode and it is to this portion of the data that a straight line is sketched or fitted. For this particular record a straight line for the more severe droughts is clearly indicated, from which probability of any drought severity may be determined. The most probable drought is located at (b) as .405 cfs. per square mile. A drought flow expected in the long run on the average once in 10 years is located at (a) as .20 cfs. per square mile. Droughts for any other return period may be read from the distribution line in a similar manner.

The slope of the distribution is readily obtained graphically by scaling $\frac{\Delta Y}{\Delta X'}$ or 0.092.

Storm Rainfall Intensity

A good example of a series of maximum values is the maximum rainfall intensity as an average for a given duration period occurring at the center of the worst storm each year in a localized geographical region. Table 5 represents such a series of data for 26 years from 11 rain gaging stations in New York City, selecting the maximum intensity for a 10 minute duration. The plotting positions (Column 5) for the 26 values, again, are in accord with Gumbel's refinement as illustrated for floods. The series plots as a straight line throughout, as shown on Figure 13. From the distribution line the probability of any intensity can be determined. Thus on the average in the long run an intensity, as an average for 10 minute duration, of 7.20 inches per hour or greater may be expected once in 20 years, located at (a); and 6.45 inches per

Table 6
WATER SUPPLY STORAGE REQUIREMENTS FOR A DEMAND OF 500 MGD.
Based Upon Mass Curve of Net Yield
Schoharie-Esopus Drainage Basin, 671 Sq. Mi.

Year (1)	Storage Required Billion Gallons (2)	in order of Magnitude (Y) (3)	Serial Number (4)	Plotting Position (X) (5)
1903	5	4	1	.0177
1904	32	5	2	.0405
1905	52	8	3	.0635
1906	40	9	4	.0861
1907	27	9	5	.1089
1908	60	14	6	.1317
1909	67	20	7	.1545
1910	58	21	8	.1773
1911	32	21	9	.2001
1912	40	27	10	.2229
1913	47	28	11	.2457
1914	76	28	12	.2685
1915	14	29	13	.2913
1916	21	32	14	.3141
1917	29	32	15	.3369
1918	49	33	16	.3597
1919	9	36	17	.3825
1920	21	39	18	.4053
1921	55	40	19	.4281
1922	60	40	20	.4509
1923	40	40	21	.4737
1924	33	45	22	.4965
1925	50	46	23	.5193
1926	50	47	24	.5421
1927	20	48	25	.5649
1928	45	49	26	.5877
1929	48	49	27	.6105
1930	94	50	28	.6333
1931	60	50	29	.6561
1932	61	52	30	.6789
1933	28	55	31	.7017
1934	39	55	32	.7245
1935	36	58	33	.7475
1936	70	60	34	.7701
1937	9	60	35	.7929
1938	8	60	36	.8157
1939	94	61	37	.8385
1940	46	67	38	.8613
1941	71	70	39	.8841
1942	28	71	40	.908
1943	49	76	41	.9305
1944	55	94	42	.954
1945	4	94	43	.977

hour once in 10 years. Intensities for other duration periods form similar straight line distributions, and from them a rational set of storm rainfall intensity curves can readily be constructed to serve as a basis for storm water drainage design.

Water Supply Storage

Fig. 14 illustrates an application of skewed probability paper to a storage problem. The maximum annual storage required each year to meet a demand of 500 mgd. was taken from a mass curve of net runoff from the Schoharie-Esopus basin for the period 1903-1945. Since drought severity is reflected in magnitude of storage required, the storage values are arranged in ascending order of magnitude, as shown in Table 6. Plotting positions for the 43 values are in accord with Gumbel's refinement and are obtained in the same manner as illustrated for floods. The storage values associated with true droughts are those points located to the right of the mode and the distribution line should be sketched or fitted through these values. The small storages associated with the less severe droughts to the left of the mode usually fall below the distribution line. The probability of any storage requirement to insure a water supply demand of 500 mgd. can be read directly from the distribution line. Thus, to protect against drought severity expected on the average in the long run once in 50 years, it would be necessary to provide storage of 100 billion gallons, located at (a) on Figure 13. This would provide storage sufficient to meet demand on 98 per cent of the years. Similarly, for drought severity expected once in 20 years the storage required would be 85 billion gallons, located at (b), providing for 95 per cent of the years.

In some storage situations the demand is set so high that reservoirs do not refill on the average each year. Under these conditions the unit of time may become 2 or 3 years and one maximum storage is selected from the mass curve for each such interval. Data are handled in the same manner except that the return period is in the new unit of time and is no longer directly in years.

(The fourth article in this series will follow in an early issue.)

IVAN M. (Mike) GLACE HONORED AT STATE COLLEGE

Ivan Maxwell (Mike) Glace, Consulting Engineer of Harrisburg, Pa., and long-time secretary-treasurer of the Pennsylvania Water Works Operators Association, was signally honored by that group at a testimonial dinner on Aug. 21. "Mike" resigned the position of Secretary-Treasurer of the Assn. last year after 23 years in the harness.

Ivan Maxwell Glace

The testimonial dinner was held on the first night of the annual meeting of the Penna. Water Works Operators Assn. at Penn State (State College, Pa.). Highlight of the dinner was the presentation of an illuminated scroll to Mr. Glace and the announcement of the establishment of an "Ivan M. Glace Award" to be made annually by the association "for the suitable recognition of meritorious work in the public water supply field in Pennsylvania."

The Scroll in full read as follows:

The Many Friends and Associates
in the
Pennsylvania Water Works Operators Association and Water Works Industry of the United States

Join in Honoring
IVAN M. GLACE

On the occasion of his retirement as Secretary-Treasurer of the Pennsylvania Water Works Operators Association after 23 years of continuous service.

For the Record
We Wish to Commend Him

For his years of unselfish service as Secretary-Treasurer of this Association.
For his unstinting and generous gifts in time to the promotion and growth of the Association and its activities.
For his careful attention to the arrangement of the details of the program and annual meetings of the Association—attention that has produced meetings of outstanding success and merit.
For his sponsorship of Association programs of particular help and benefit to the operators of smaller water works systems.
For a personality and character that has made the name of "Mike" Glace a synonym for good humor, good companionship, and good sportsmanship.
For these and many other reasons that make Mike our friend and deserving of such honor, we hereby establish an annual award of the Association to be known as the "Ivan M. Glace Award"; an award for the suitable recognition of meritorious work in the public water supply field in Pennsylvania.

The presentation was made by John H. Murdoch, Jr., Vice Pres. and Counsel of the American Water Works Co. Mr. Murdoch spoke in glowing terms of the fact that Mike Glace had been one of the greatest influences in the Penna. Water Works Operators Assn. In his response to the presentation, "Mike" said, "There must be another Mike Glace—that doesn't sound like me." He then went on to say that he appreciated the honor bestowed on him but that credit should also go to Mrs. Glace and to his daughter (Mrs. John Roberts) as well as to the many officers who had helped him during those 23 years.

Scroll Presented to Mr. Glace

Following the presentation of the scroll, George W. Naylor, President of the Association, called on Roy Evans (Mueller Co.) who presented to Mike a new set of golf clubs and a dozen golf balls—a gift from many of "Mike's" friends.

Sandy's Water Meters Sandy

The following item was sent out over U.P. wires under date line of Aug. 16.

SANDY, Utah, Aug. 16 (U.P.)—Most of Sandy's water meters weren't working today. Reason—there was sand in the mains and meters, according to city officials of Sandy.

WATER RATES IN THE CITY OF HALIFAX

Experiences in Establishing a New Rate Schedule, and Its Outcome

by

IRA P. MACNAB
General Manager
PUBLIC SERVICE COMMISSION
HALIFAX, NOVA SCOTIA

BEFORE discussing the new schedule of water rates and the method by which it was calculated, it will, I think, be helpful if a brief history of the Halifax Water System is set out.

The City of Halifax was founded in 1749 and incorporated in 1841. The City is situated on a peninsula and is connected with the mainland by a neck of land only one and a half miles long, between the North West Arm and Bedford Basin. The balance of the City is entirely surrounded by harbours with deep water. From the water the land rises steeply to a general plateau about 170 feet elevation above mean low tide. Above the general plateau there are two higher areas in the City, one area rising to about 225 feet and the highest to about 247.5 feet. Because of this topography there are three general pressure areas in the City, known as the low service, the high service and the "super" high service, the latter serving only a few hundred customers.

The present water system was started in 1844 by a Company of local men, under the name of the Halifax Water Company, with a capital of £15,000 sterling. Water was turned on in the City for the first time in September, 1848.

In 1861 the assets of the Halifax Water Company were purchased by the City for the sum of £52,000, and from then until 1872 the system was operated by three paid water commissioners.

In the year 1872 the control of the water was vested in a committee of the City Council, known as the Board of Works. Operation under the Board of Works continued until the end of 1944, when the operation was vested in the new Public Service Commission of Halifax.

This Commission was created by Act of the Legislature of Nova Scotia in 1944, the ownership remaining vested in the City. The act creating the Public Service Commission provided for five members, three of which are independent citizens appointed by the City Council, the remaining two being the Mayor and one member of council.

The Author

The author of this article, contributed at our request, has had the unique experience of having served as chief engineer of the Nova Scotia Public Utilities Commission which controls, regulates and passes on rate schedules for *all* municipal utilities as well as private companies.

Now, as General Manager of the municipally owned Public Service Commission of Halifax, he has had the experience of developing a 45% rate increase for water service and successfully defending the proposed schedule, involving a drastic rate increase, before his old Board of Utility Commissioners.

Mr. Macnab's experience in connection with a regulatory body, and more recently as a water utility manager developing a rate increase schedule which puts his utility in a sound financial status, is likely the reason behind his recent appointment to AWWA's important Committee on Water Rates.

Before dealing specifically with the matter of rates, there is one other condition under which this system operates that must be explained before a complete understanding of our system of operation is clear.

All Municipal Utilities Under Public Utility Commission Regulation

In the Province of Nova Scotia all Public Utilities are regulated and controlled by the Provincial Board of Commissioners of Public Utilities, under authorization of a statute of Nova Scotia known as the Public Utilities Act. This Board has control of *all* Utilities operating in the province whether privately or municipally owned, including all municipally owned water systems.

The Board of Commissioners of Public Utilities of Nova Scotia must approve all rates and all capital construction costing in excess of $1,000 for any specific piece of work. The Board also has authorization to fix rates of depreciation on various classes of plant and property, and to fix the rate of return that any Utility is allowed to earn on its fair value. It may be of interest to know that the Public Utilities Act specifies the rate base as being the original cost of the property used, and useful, at the time the value is fixed, less accrued depreciation as of the same date, plus an allowance for working capital.

As already stated, the Public Service Commission of Halifax came into being by an Act of Legislature in the year 1944 and took over the operation of the system as of January 1, 1945.

During the war years Halifax—then known as an "East Coast Port" had its population doubled from 65,000 in 1939 to approximately 130,000, at the close of the war and in addition the use of the port by allied shipping increased several thousand percent, while railroads and industries also greatly increased their activity. These conditions imposed a tremendous burden on the water system. When the Commission took over therefore, it took over a system which had been incompletely maintained for a number of years and at a time when it was very difficult to secure necessary equipment for rehabilitating the system or for improving facilities.

When it is understood that the transmission mains in service were those that had been installed when the City had a population of approximately 35,000; and, that these mains were required to service almost four times that population, together with wartime industrial and shipping activities, it will readily be understood that conditions were very bad.

One of the first things that it was found necessary to do, was to construct a booster pumping station on the main transmission lines to improve pressure. This station cost approximately one-quarter million dollars.

The high service system of the City is regulated by a concrete reservoir

having a capacity over 3,000,000 gallons. This reservoir was in very bad condition and had to be renovated at a cost of approximately $90,000. Chlorinating facilities were antiquated and inadequate and a new automatic chlorinating station was found to be absolutely necessary. This was built at a cost of another quarter million dollars. In addition it was found that inadequate maintenance over the years had resulted in serious leaks over the whole system. The Pitometer Company was called in to make a leak survey, which, when completed disclosed the fact that about 50% of the water coming into the system was unaccounted for. While the system was 100% metered it was found that about 7,000 meters of a total of 13,500 were either not registering or registering considerably under consumption.

During all previous years it had been the practice to supply ½" service pipes, the utility paying for the pipe from the main to the curb line and supplying the meter, the customer having to pay for the cost of the service pipe on his own property. It was decided that minimum size service pipe would be fixed at ¾".

A Corrosive Water

The water supply of the City is all secured from lakes with approximately 20 square miles of drainage area, nearly all of which is covered by a forest growth, about 50% of the growth being evergreen, the balance deciduous. The result of this is that our water is somewhat on the acid side, having an average pH of slightly under 5. On examination it was found that many of the old ½" services were so badly corroded or encrusted that the volume of flow to the customers' premises was so seriously reduced that it became necessary to adopt a policy of rapid replacement of service lines. Many hydrants also were in need of either replacement or repairs and a great deal of work was also necessary to get the hydrants in proper operating condition.

From the foregoing it can readily be seen that the new management was faced with a series of major problems. After getting the organization built up and a complete survey made it was estimated that $600,000 would be required to put the system in fair operating condition, without considering expenditures for new capital work. Due to increases in wages and the increase prices of materials this estimate has now been increased to $800,000.

Deficit Necessitated Rate Revisions

With the organization built up, the meters put in operating shape, proper accounting methods installed, it was found by the end of 1947 that after providing for operating expenses, capital carrying charges, sinking funds, etc., and providing a reasonable fund for depreciation, that the year's operations showed a deficit of approximately $150,000. This result clearly indicated that more revenue was necessary to provide for rehabilitation, necessary maintenance and operation so that reasonable and adequate service could be furnished to the consumer and it was agreed that a new rate schedule would have to be set up.

The rate schedule in effect at the time had been approved in 1926 and was as follows:

SERVICE CHARGES

Size of Meter	Quarterly Charge
⅝ inch	$ 0.50
¾ "	1.00
1 "	1.25
1½ "	2.25
2 "	2.50
3 "	3.75
4 "	5.00
6 "	7.50
8 "	22.50
10 "	30.00

CONSUMPTION RATES

For the first 100,000 gals. per quarter 20 cts. per 1,000 gals.
For the next 1,150,000 gals. per quarter 17 cts. per 1,000 gals.
For the next 6,000,000 gals. per quarter 12 cts. per 1,000 gals.
For all over 7,250,000 gals. per quarter 6 cts. per 1,000 gals.
All consumptions in imperial gallons

MINIMUM BILLS

The minimum bill for water service shall be the service charge plus fifty cents per quarter.

As will be seen from the above rates the customer with a small service could use 2,500 gallons per quarter under the minimum bill. Halifax actually had about 2,000 customers getting service at $4.00 per year and about 50% of all the customers were getting their water for $6.00 a year or under.

When it is considered that the subsoil of Halifax is almost 50% rock, and for that reason the cost of service pipe from the main to the street line was about $100, and the meter cost installed was about $20.00, it can readily be understood why a deficit was incurred in providing water service. After considering all the facts it was decided that we would have to have an increase in revenue of approximately 45% if good operation and maintenance was to be carried on, and the necessary rehabilitation was to be paid for out of revenue.

How to Develop the Fairest Rate Schedule the Next Problem

The question then before us was how to get the necessary increase and distribute the cost as fairly as possible on all customers.

It was found on a careful study that the actual operating costs of supplying the water was slightly over 10 cents per 1,000 gallons at the time. Therefore, it was perfectly clear that the small customer was paying much too small an amount. Likewise, the very large customer taking a material amount of water at the 6 cent rate was also paying much less than his share.

There was one redeeming feature in the situation. That was the rates, as approved in 1926, had provided a formula for arriving at the cost of fire protection which resulted at the time of the rate investigation in a payment by the City of about $160,000 a year to the Commission for fire protection.

The author is firmly of the opinion that fire protection is a very definite service furnished, which has a real cash value to the property owners and therefore the cost of fire protection is a legitimate charge against the property protected.

This practice has been accepted and agreed upon by the Board of Commissioners of Public Utilities of Nova Scotia for many years. The money is raised by a supplemental tax on the assessed value of the property protected.

A Demand Charge Considered Basic

Our first step therefore was to determine the proper allocation of the cost of supplying domestic and industrial customers and providing adequate fire protection. It was decided that the only way this could be done with reasonable equity was *on the basis of the demand* that could be imposed on the system by the general service and fire protection requirements. We therefore worked out as closely as possible the actual demand of the previous year from our recording master meters for general service and the demand which could be imposed on the system by the existing fire apparatus, which demand was checked against the various fire underwriters formulas for this purpose. Using the demands so found, the various capital accounts were allocated between general service and fire protection. In making this allocation some items were clearly 100% for general service and others were as

clearly 100% for fire protection. The balance of items on capital account were allocated between the two classes of service on the basis of judgment, but only after a very careful consideration of each item.

In the same manner the operating expenses, capital carrying charges and depreciation were allocated. When these calculations were completed it was found that the cost of providing fire protection in the City of Halifax was 23% of the total annual cost and it was therefore decided that 23% of revenue should come from it.

Having reached this conclusion, the next problem was to devise a scheme of rates for general service to raise the 77% not provided in the form of fire protection income. It was decided that the most equitable distribution of these charges possible would be *on the basis of the demand* that any customer could impose on the system. Having reached this conclusion, it was decided that this basic service charge should be sufficient to cover the capital carrying charges and depreciation of that portion of the system not included in fire protection.

In calculating the demand it was based on the quantity of water that could be delivered through the various sizes of meters with a loss of 10 feet of head, based on an average pressure of 40 p.s.i. While it is agreed that all customers do not receive service at the average pressure of 40 p.s.i. this was considered to be the most equitable method that could be devised at this time.

On this basis the annual cost chargeable to services with a ⅝" meter worked out at $13.59. This charge was then pro-rated on the basis of flow for the various sizes of meters with equal loss in head. The loss of head was checked from the test curves of the meter.

While it was found that a rate of 20 cents per 1,000 imperial gallons, as the average, would give the required revenue, the problem of dividing the consumption into blocks to provide the average of 20 cents was difficult. There did not appear to be any rule that would apply, so after a lot of study and using the good old method of "cut and try" the following schedule was agreed upon. After public hearing it was approved by the Board of Commissioners of Public Utilities.

RATES FOR METERED SERVICE

(1)—Minimum Bills

Size of Meter	Quarterly Payment	Water Included in Min. Bill per Quarter
⅝"	$ 4.50	7,000 gallons
¾"	4.50	7,000 "
1"	8.75	16,000 "
1½"	15.00	28,000 "
2"	30.00	55,000 "
3"	50.00	95,000 "
4"	75.00	140,000 "
6"	125.00	235,000 "
8"	225.00	420,000 "
10"	300.00	560,000 "

(2)—Consumption Rates

For the first 3,000,000 gallons per quarter over and above the quantity allowed with the minimum bill.....25c per 1,000 gals.
For all additional consumption per quarter.....10c per 1,000 gals.

(3)—Fire Protection Rates

The City shall make payment annually to the Commission for fire protection service. The amount to be so paid by the City to the Commission shall be computed as follows:

The amount to be so paid in the year 1949 shall be.....$190,034
For each succeeding year the sum shall be.....$190,034

Or the sum of 14% of the operating expense for the year plus 31% of the total taxes (if any paid), depreciation and a 6% return on the rate base for the year, whichever is the greater.

(4)—Sprinkler Systems

$25.00 per year or 2c per sprinkler head per year, whichever is the greater.

Service or Demand Charge Covered in "Minimum Bill"

It will be noted that the "Service Charge" is not shown as such as after consideration it was decided that a "Minimum Bill," entitling the taker to a reasonable amount of water (fixed at 7,000 imperial gals. per quarter for ⅝" and ¾" meters), would be the most practical method of making the charge, because it is better understood and more acceptable to the customers.

As to the accuracy of our calculations it will be noted above that we required an increase of 45% and from the first year's operation under the new schedule, including a considerable number of new customers added that year, our revenue was increased by 48%.

It must be remembered that under this new schedule approximately 2,000 customers were being increased from $4.00 per year to $18.00 per year, or 450%, and that another 4,000 customers, all of which had been receiving water service at less than $6.00 a year were being raised to $18.00 a year, or better than a 300% increase.

First Year's Results

In the first full year's operation under the new rates in addition to regular operating procedures and maintenance approximately $90,000 was spent on deferred maintenance, all capital carrying charges and depreciation were provided for and a surplus of about $100,000 was paid to the City in lieu of taxes.

When it is considered that as at December 31, 1949, the original cost value of the system was $7,135,672, with a depreciated or rate base value of $5,283,745, a $100,000 annual return on investment is not unreasonable.

An Important Consideration

Before bringing this case to the Board of Commissioners of Public Utilities for approval, the whole problem was explained to the members of the City Council who are the elected representatives of the people. Publicity was also given by talks to service clubs and through the medium of the newspapers and paid advertisements, the public was informed as fully as possible as to the actual situation. The final result was that after the rates had been increased complaints were received, with regards to the increase, from only 400 out of 14,000 customers, less than 3%.

This experience tends to strengthen the belief that if the public is adequately and fully informed in advance the great majority are prepared to pay justifiable rate increases for *satisfactory* water service.

Changes in Engineering Firm

The firm of Jones, Henry and Schoonmaker has announced the withdrawal of Spencer D. Downing and Bernal H. Swab as junior partners. The consulting engineering practice of the firm is being continued by the remaining partners Thomas B. Henry, George N. Schoonmaker, and Leon G. Williams under the same firm name and at the same address, 821 Security Building, Toledo, Ohio.

Mr. Swab has become associated with Blundon, Snyder and Small in Keyser, W. Va., and Mr. Downing has entered private consulting practice in Bowling Green, Ohio.

SIMPLIFIED CALIBRATION OF PHOTOMETRIC INSTRUMENTS FOR RESIDUAL CHLORINE

by

MICHAEL J. TARAS
Senior Sanitary Chemist
DEPT. OF WATER SUPPLY
DETROIT, MICHIGAN

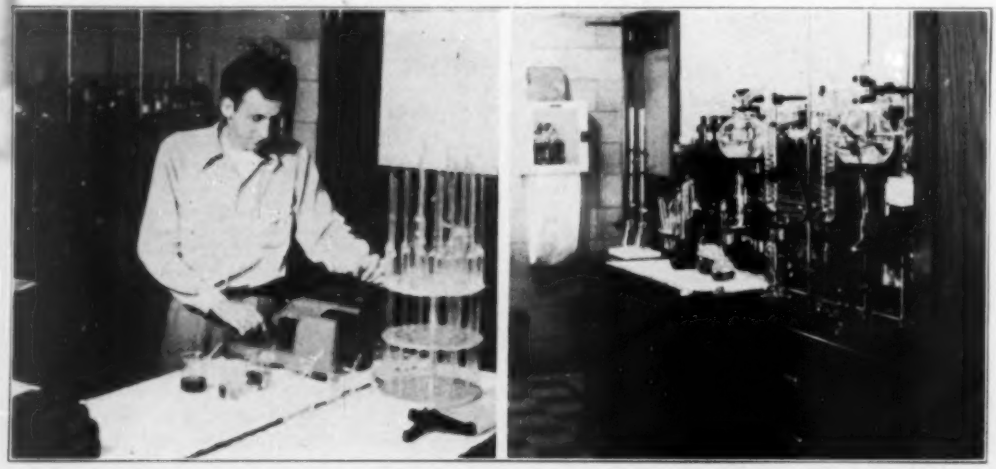
THE rapid emergence of photometry in recent years is indicated by the growing volume of literature devoted to its application in laboratory analysis. Several reasons account for the phenomenal growth of photometry. First, the photometer frequently possesses an accuracy denied to normal human vision. Second, the work involved in the preparation of temporary or permanent standards is often reduced to a minimum. Consonant with the prevailing trend *Standard Methods*[1-A] recommends resort to photometric instruments for many analyses.

Customary practice in calibrating a photometer is to weigh a calculated quantity of the active ingredient on an analytical balance, dissolve it in a given volume of distilled water, and mix the proper aliquots with the specified reagents to produce the final color. Virtually all ions or substances which are available commercially in a high chemical purity can be handled in this manner. Free-chlorine, however, is among the notable exceptions. The impossibility of weighing the gas to the fine accuracy imperative in analytical work, couple with the peculiar propensity of chlorine to react with many dissolved substances, requires the selection of another approach. The use of considerable quantities of distilled water free of chlorine demand is among the measures adopted. Another alternative is the simultaneous checking of the chlorine content by such procedures as amperometric or methyl orange titration. At any rate, a foolproof standardization entails considerable exacting work and the exercise of superb technique.

The Author

A Simplified Method of Calibration

A simplified method of calibration was suggested by a spectrophotometric study of the orthotolidine: free-chlorine reaction in Detroit water. Amperometric titrations of superchlorinated Detroit tap water and parallel spectrophotometric measurements of the yellow holoquinone color developed by orthotolidine disclosed an obedience to Beer's law when a semilogarithmic plot was made of the transmittance obtained with a 1 cm. light path and the chlorine concentration. Conformity to Beer's law prevailed beyond 20 ppm. chlorine, to the effective limit of the Beckman Model DU spectrophotometer, which was used in the investigations at wave length setting of 490 *mu*. These experiments indicated the possibility of calibrating a filter photometer within an average accuracy of 0.01 ppm. in the range from 0.00 to 0.15 ppm. chlorine; 0.02 ppm. from 0.15 to 0.50 ppm.; 0.05 ppm. from 0.50 to 1.00 ppm.; and, 0.10 ppm. from 1.0 to 2.0 ppm. This represents a substantial improvement over the accuracy possible by the visual com-



Analyst Operating One of the Photometric Instruments and a Shot of a Section of the Laboratory Where Titrations are Made.

parison of samples against permanent color standards. Moreover, the calibration can be performed with glassware and chemical reagents ordinarily found in every water plant laboratory.

Once standardized, a photometer can be expected to yield acceptable accuracy if the same color filter is employed, and the photocell and the light bulb remain in good working order. One model standardized for free-chlorine more than three years ago in this laboratory still continues in perfect calibration. Recent checks of this instrument against the Wallace and Tiernan amperometric titrator showed readings within an average experimental error of plus or minus 0.01 ppm. free available chlorine in the range up to 1.00 ppm. A simple way of determining photocell and light bulb efficiency is to note the transmittancy of a 0.0005 M. potassium dichromate solution at daily intervals in the event the instrument is in continuous operation.

Ordinary tap water which had been coagulated with alum, passed through rapid sand filters for turbidity removal, and chlorinated to a final 0.5 ppm. free available residual, by normal plant treatment processes for the satisfaction of the full chlorine demand, was used successfully in all of the simplified experiments.

Experimental Procedure

The turbidity-free tap water, which has been brought to room temperature, is dosed to a residual of 10 to 15 ppm. with heavily chlorinated water drawn from under the bell jar of a chlorinating machine feeding gaseous chlorine. After the chlorine has been thoroughly mixed into the water for several minutes with a glass stirring rod, three 250 ml. portions are poured off accurately into volumetric flasks for titration. Another 95 ml. sample is measured accurately in a 100 ml. graduated cylinder and poured with vigorous stirring into a 250 ml. beaker containing 5 to 8 ml. of standard orthotolidine reagent. The orthotolidine should be added at the rate of 5 ml. for every 10 ppm. of chlorine[2]. Following 10 seconds of stirring, add 5 ml. of 0.5 per cent sodium arsenite solution and continue the stirring an additional 10 seconds. From this point, one of two alternative procedures may be followed.

Alternative I.—Exactly 50 ml. of the orange colored solution are transferred quantitatively with a volumetric pipette to a 250 ml. beaker containing 50 ml. of distilled water, also measured with a pipette. Upon 10 seconds of stirring, 20, 25, and 30

Table I

Comparison of Chlorine Values—Simplified vs. Exact Calibration Methods*

Transmittance	Exact Method	Simplified Methods	
		Alt. I	Alt. II
(per cent)	(ppm. Cl_2)	(ppm. Cl_2)	(ppm. Cl_2)
10.0	1.92	1.99	1.91
11.0	1.80	1.86	1.80
12.0	1.67	1.73	1.69
13.0	1.57	1.61	1.59
14.0	1.47	1.50	1.50
15.0	1.37	1.40	1.42
16.0	1.29	1.31	1.34
17.0	1.20	1.22	1.26
18.0	1.11	1.14	1.20
19.0	1.07	1.08	1.13
20.0	1.04	1.04	1.08
22.0	0.96	0.96	1.00
25.0	0.87	0.86	0.88
28.0	0.78	0.77	0.79
30.0	0.73	0.72	0.73
35.0	0.62	0.59	0.60
40.0	0.52	0.50	0.50
45.0	0.44	0.43	0.43
50.0	0.38	0.37	0.38
55.0	0.33	0.32	0.33
60.0	0.28	0.27	0.28
65.0	0.24	0.23	0.24
70.0	0.20	0.19	0.20
75.0	0.16	0.15	0.16
80.0	0.12	0.12	0.12
90.0	0.06	0.06	0.06
100.0	0.00	0.00	0.00

(Above results portrayed graphically in Fig. 1)

*95 ml. sample volume, 25 mm. diameter tubular cell path, color filter with transmittance peak at 425 *mu*.

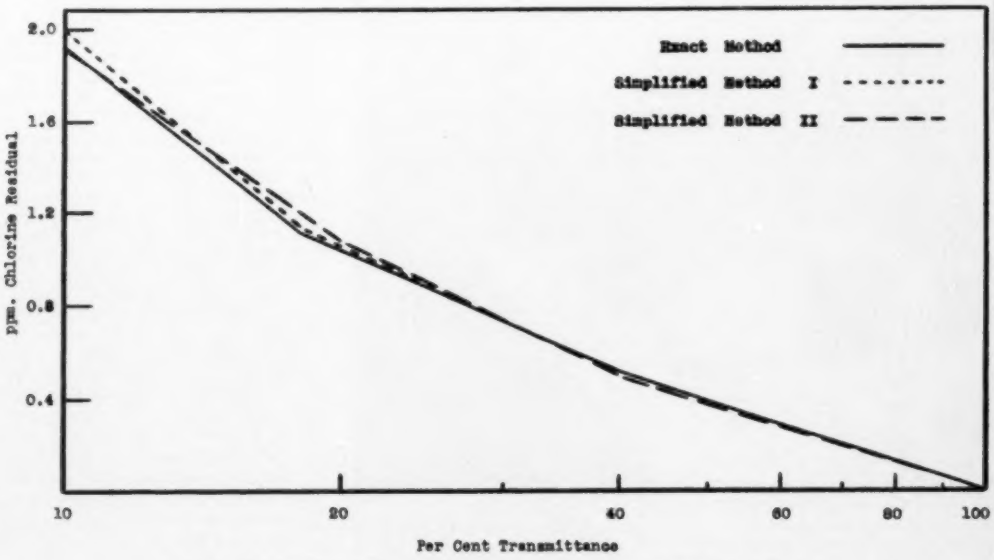


Fig. 1—A Comparison of Chlorine Calibration Curves by Simplified and Exact Methods

ml. portions of the second solution are withdrawn by means of volumetric pipettes and mixed with 80, 75, and 70 ml., respectively, of distilled water in separate 250 ml. beakers in the manner just described. All of these solutions are stirred thoroughly and 50 ml. portions of each solution are progressively diluted with equal parts of distilled water to a final color representative of approximately 0.1 ppm. residual. It is advisable that the proper volumes of distilled water be measured out in advance of the run in the 15 to 20 beakers needed for the several dilutions.

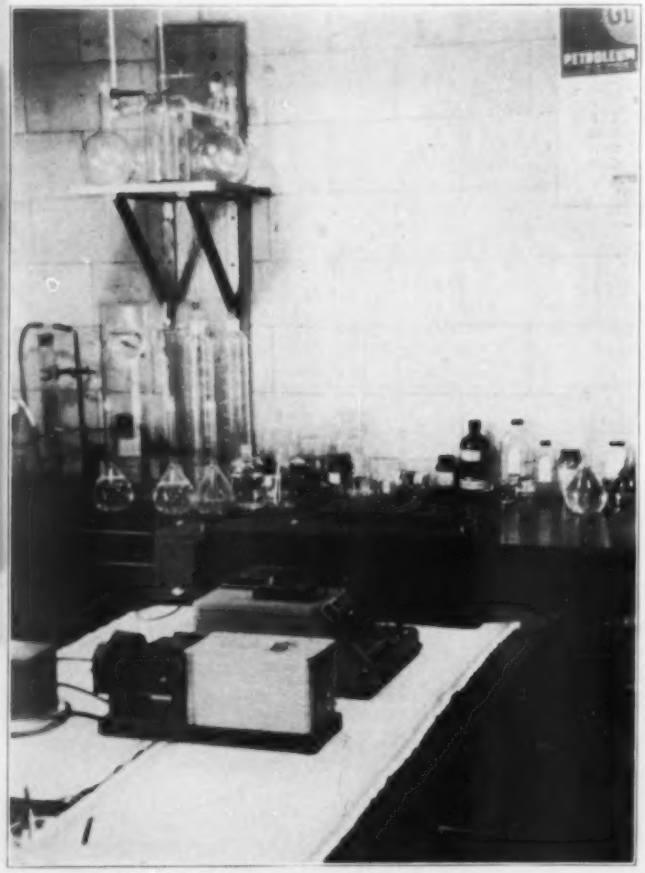
Alternative II.—Fifty ml. of the orange colored solution are transferred quantitatively with a volumetric pipette to a 600 ml. beaker containing exactly 200 ml. of distilled water. This solution "A" has a color intensity approximately one-fifth of the chlorine concentration in the original dosed sample. After 10 seconds of stirring, the transmittance value is determined on the 50 ml. portion withdrawn by means of a volumetric pipette. The withdrawn volume is replaced by adding 50 ml. of distilled water. The resulting solution "B" has a color strength equivalent to 0.8 of the chlorine concentration in solution "A". After stirring, 50 ml. are withdrawn for photometric determination, and the volume is again restored with 50 ml. of distilled water. The process is repeated until a dilution corresponding to approximately 0.1 ppm. of chlorine is reached. From 15 to 20 beakers will be required to receive the 50 ml. portions for transmittance readings.

Whichever alternative procedure is adopted, the calibration should be accomplished within half an hour, in order to preclude possible significant color fading. For this reason, it is suggested that a team of two workers undertake the task. While one individual is cutting the color of each successive solution, the partner can be obtaining quantitative checks of the first chlorine residual by titrating the 250 ml. samples (transferred to 500 ml. Erlenmeyer flasks) with sodium thiosulfate; and thereafter making the photometric readings. For the titration a 0.02 N. sodium thiosulfate solution affords a sharper starch-iodite end point and is therefore preferrable to more dilute standards. An average of the three titrations is accepted as the chlorine content of the initial solution. This value is used in calculating the chlorine equivalent of the diluted colors; consequently, the titrating solution should be standardized with care.[1-B]

A slight sacrifice in accuracy, of the order of 0.01 ppm. above that already indicated in the range 0.00 to 0.50 ppm. chlorine, resulted from the substitution of graduated cylinders in place of volumetric pipettes for dilution purposes.

The semilogarithmic plot of per cent transmittance (logarithmic axis) against the corresponding chlorine concentration normally results in consecutive and connecting straight lines with three changes of slope in the region from 0.00 to 2.0 ppm., the position of change depending upon the photocell, the color filter, and the sample cells supplied with the individual instrument. One filter photometer used in this laboratory yields a straight line up to 0.60 ppm., at which point a change in slope occurs and holds over the range 0.60 to 1.10 ppm., with a final slope change making its appearance over the remainder of the interval to 2.0 ppm. The instrument is calibrated for a combination of a blue filter with a transmittance peak near 410 *mu.* and the tubular cells of 17 mm. diameter. The three slope changes for the two instruments of another manufacture which serve in the departmental control laboratories occur at 0.50 and 1.10 ppm., operation being with color filters exhibiting maximum absorption near 425 *mu.* and tubular cells of 25 mm. diameter.

The Beckman Model DU spectrophotometer enables the determination of chlorine residuals beyond 20 ppm. at a wave length of 490 *mu.* and a 1 cm. cell path. Contrasted with the average filter photometer, the semi-



Three Photometric Instruments Used in This Work

Front to rear: (1) Cenco-Sheard-Sanford Photolometer made by Central Scientific Co. of Chicago; (2) Fisher Electrophotometer made by Fisher Scientific Co. of Pittsburgh, Pa.; (3) Model DU Beckman Spectrophotometer made by National Technical Laboratories of South Pasadena, Calif.

logarithmic plot of the spectrophotometric data produces a straight line throughout the range. However, for maximum accuracy it has been found necessary in this laboratory to run a standard chlorine solution simultaneously with the samples, thus limiting the applicability of this instrument for routine purposes.

Calculations

As will be observed, the color of the original sample is developed in accordance with the procedure proposed by Chamberlin[2] and Hallinan[3], and now recommended by *Standard Methods*[1-C]. Therefore, the calibration is applicable for the determination of free available chlorine by the customary laboratory procedure of adding 95 ml. of sample to 5 ml. of the usual orthotolidine reagent followed by 5 ml. of 0.5 per cent solium arsenite solution. Since a 95 ml. sample is used for the initial color development an appropriate correction must be applied to the calculation of the first diluted color.

Alternative I.—The chlorine equivalent of the first color dilution amounts to 50/95 or 52.6 per cent of the original concentration. For example, if the average of three sodium thiosulfate titrations disclosed a chlorine content of 10.0 ppm., then the first 50 ml. color dilution of this original solution would represent the product of 10 ppm. and 0.526 or 5.26 ppm. chlorine. The 20, 25, and 30 ml. aliquots of this initial dilution would represent the following chlorine values:

$5.26 \times 0.20 = 1.05$ ppm. chlorine for the 20 ml. aliquot.

$5.26 \times 0.25 = 1.31$ ppm. chlorine for the 25 ml. aliqtiot.

$5.26 \times 0.30 = 1.58$ ppm. chlorine for the 30 ml. aliquot.

The equal dilution of 50 ml. portions of each of these aliquoted colors would result in halving the chlorine equivalent. To carry the case of the 20 ml. aliquot to a logical conclusion: the first 50 ml. dilution would be equivalent to 0.53 ppm. chlorine, the second dilution 0.26 ppm., and the third 0.13 ppm.

Alternative II.—The chlorine value of the first 50 ml. dilution to 250 ml. is expressed by the following mathematical equation:

$$\text{ppm. } Cl_2 \text{ of 1st dilution} = \frac{\text{ppm. } Cl_2 \text{ found by titration} \times 0.526}{2.5}$$

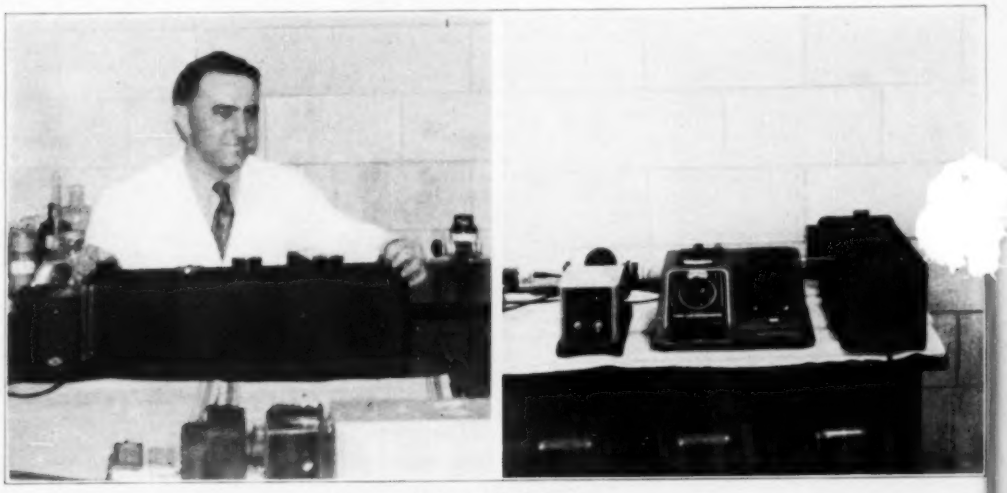
Thereafter, the withdrawal of one-fifth of the volume leaves 0.8 of the color in solution. Every successive dilution, therefore, represents 0.8 of its predecessor. Using the 10.0 ppm. initial concentration cited in Alternative I, the first 50 ml. color dilution to 250 ml. is equivalent to the product of 10.0 and 0.526 divided by 2.5, or 2.10 ppm. All succeeding dilutions are treated in the manner applied to the following two instances:

$2.10 \times 0.8 = 1.68$ ppm.;
$1.68 \times 0.8 = 1.34$ ppm.;
etc.

Discussion

The calibration data presented in Table I and Fig. 1, are typical of the accuracy possible with the simplified procedures. The exact data were collected by a team of two men working four full eight hour days, using chlorine demand free distilled water throughout and methyl orange titration checks[4] for each solution photometrically tested. The methyl orange dye necessary for this work must be of the highest chemical purity and not merely a grade suitable for indicator purposes. Each of the simplified procedures reduced the total calibration time for a team of two men to three hours, including all such preliminary preparations as standardization of solutions and cleaning of glassware. Approximately 50 colored solutions, taken consecutively and without any attempt at selection, were measured photometrically in the construction of the curve on which the simplified data in Table I and Fig. 1 are based.

If only one man is available for the calibration the number of dilutions that may be performed for photometric purposes should be restricted to a reasonable series, in order to keep color fading to a minimum. The working time for a single run should be limited to less than 30 minutes. Also, the more color concentrations that can be measured the greater will be the dependability of the resulting curve. A minimum of three such runs as herein outlined, at three different original chlorine strengths in the 10 to 15 ppm. chlorine range, is suggested for the accumulation of the calibration data.



Photometric Instruments

The Author operating a Beckman Spectrophotometer. On right (from left to right) Central Scientific Co.'s Photolometer; Fisher Scientific Co.'s Electrophotometer; Nat'l Technical Laboratories' Beckman Spectrophotometer.

The simple method is not intended to supplant more exact calibration practices. Neither is it recommended for research purposes. The ideal way to calibrate a photometer is to reproduce the normal test conditions. Needless to say, a good standardization requires more time than many laboratories are willing to accord to the task. Successful calibration of filter photometers for research requirements has been accomplished in this laboratory by parallel checks of numerous chlorine solutions of varying concentrations determined by such methods as amperometric or methyl orange titration. In this way, the slight deviations in the data have been detected and adjusted; and the reliability of the calibration lines established. Even under the best circumstances an experimental error of plus or minus 0.01 ppm. must be anticipated in the chlorine range below 1.0 ppm., with increasing errors above that level. The magnitude of the error above 1.0 ppm. depends on instrumental response and on the individual performing the determination. Examination of Table I and Fig. 1 reveals that as the transmittancy approaches 10.0 per cent the chlorine equivalent of each transmittance unit assumes an increasing value. Accordingly, any effect on the reading, whether of a personal or instrumental nature, takes on added import.

The pre-eminent position of the chlorine determination in water plant operation underlines the need for a procedure, albeit not strictly exact, for calibrating a photometer. The permanent standards, though acceptable color matches, fall short of perfection by virtue of preparation from inorganic chromium salts, as opposed to the organic color developed by orthotolidine. The slight differences in the chromate and chlorine solutions have been brought out in our laboratories during the afternoon and night shifts when the transition from light to dark and vice versa accentuates the disparity in the color tone between the water samples and the standards under comparison. At these times, a question arises as to the chlorine residual, necessitating a readjustment of the eye to the new color system. In the range above 0.50 ppm. chlorine the human eye fails to differentiate sharply the slowly increasing color intensities. Photometric response, on the other hand, is impaired to a lesser degree in the same region. The introduction of photometric instruments into routine control in our departmental laboratories has eliminated the guesswork and confusion attendant upon color matching.

Acknowledgement: The author is deeply indebted to Douglas Feben for invaluable suggestions, and to William J. Redman, Henry T. Lane, Allen M. Hill, and Michael Garnell for technical assistance in accumulating the data on which this paper is based.

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RECLAIMED SEWAGE

To Be Used as Water Source in Giant Steam Generating Plant

The first major project in California for reclaiming water from municipal sewage for industrial use is now being planned. This disclosure has been made recently by the Southern California Edison Co. which is contemplating the recovery of 8 mgd. of water from Los Angeles County sewage for the operation of a projected steam-generating electric plant to be constructed in the San Gabriel Valley area.

It is believed that this will mark the first time that water reclaimed through sewage treatment and effluent processing in plants especially constructed by a private company for such use in operation of a steam generating plant.

Negotiations are under way between the Edison Company and the officials of the Los Angeles Sanitation Districts for permits and contracts which will legalize construction and operation of the proposed sewage treatment and effluent processing plant and tapping of the District's sewers for the "crude water supply" to the extent of 8 mgd. or more per day.

The reclaimed water is to be used primarily for cooling purposes in steam-condenser operation, and particular significance is attached to this promising project because of the present critical water supply situation in Southern California, and the current battle with Arizona over water from the Colorado River.

A further significant point in this proposed undertaking is the fact that it will be the first instance wherein an industrial plant has ever entered into contract to purchase crude domestic sewage and construct a sewage treatment plant at its own expense for the sole purpose of reclaiming effluent for processing into a satisfactory (always dependable) source of industrial water supply.

Why not complete the cycle of used, re-conditioned, re-used, and again reclaimed, water supply by sale of the used condenser cooling water, with only BTUs. added, to some Irrigation District for return to the land? And it is boasted by the packing industry that they use everything about a pig except the squeal.

Course in Municipal Management

For the first time in New England, an integrated, evening course in Municipal Management will be offered this Fall at Northeastern University in Boston.

The Evening School of Business has designed this two-year program of study to promote efficiency, good management and sound economic principles in local government.

These courses which are planned to meet the need of town and city officials will be under the direction of Mr. John W. Agnew, Director of the Municipal Finance Department of the First National Bank of Boston.

Emphasis will be placed on principles of public works, municipal law, department administration and inter-relations, state and local department relations, and municipal accounting, finance and assessing.

Cyanide for Gold Mines Produced from Sewage Works Byproducts

A news item in *Chemical and Engineering News* states that African Explosives and Chemical Industries, Ltd., in its Klipspruit factory is producing cyanide from locally obtained materials, including byproducts of the Sewage Treatment Plant of Klipspruit, S.A., which have hitherto gone to waste. The news item does not name the byproducts used from the sewage disposal plant. The cyanide is supplied to 12 gold mines for gold extraction in tank trucks in the form of calcium cyanide in solution form which is especially well adopted to storage and ease of use.

AWWA WATER RESOURCES DIVISION AT PHILADELPHIA

DURING the annual AWWA Convention held in Philadelphia, May 21 to 26, the Water Resources Division held three sessions, one of which was a general session. This latter was devoted to a panel discussion on the "SAFE YIELD FROM SURFACE STORAGE RESERVOIRS."

Surface Storage

Introduction	Summation
Earnest Boyce	*W. W. Brush*
Prof. San. Engr.	*Editor*
Univ. of Mich.	*Wat. Wks. Engr.*
Ann Arbor, Mich.	*New York City*

The panel discussion was confined to storage reservoirs in the Eastern United States and was introduced and moderated by EARNEST BOYCE, Prof. of Munic. and San. Engr., Coll. of Engr., Univ. of Michigan, Ann Arbor, Mich.

Overall Trends

The first paper on the panel was a review of overall trends by C. G. PAULSEN, Chief Hydr. Engr., U.S. Geol. Survey, Washington, D.C. Mr. Paulsen pointed out that for a number of years there had been a downward trend in available water supply and this country is now faced with the need for long term projects to develop stream facilities.

In order to proceed with these long term projects it is essential that we know the safe yields of streams and we must use modern methods of hydrologic analysis to learn them.

All that one can expect from a storage reservoir is the average flow. For any particular locality it is essential therefore to determine the probable drafts and thus the storage required.

Mr. Paulsen pointed to long term trends as determined by tree rings and clay varves which are indicative of past cycles of weather and precipitation. It is now well known from such studies that this world has seen a changing climate during the past 4000 years. Out of that period we have only 125 years of history of recorded rainfall. While it is known that the ice is still receding, there is little reason to believe that our climate in the next 100 years or so will be greatly different from that of the past 100 over the long term range.

On the other hand, studies are lacking on native streams and while the USGS does have some recent record of dry and wet seasons, it can not be definitely assumed that these records are typical of what is happening on the long term cycles.

Factual Information

How researchers piece together information on climate was told by W. B. LANGBEIN, Hydr. Engr., U.S. Geol. Survey, Washington, D.C. Studies of modern climate begin with the collection of information back to about 6500 B.C. For 45 centuries there was a hot arid climate then came the little ice age about 2000 to 1600 B.C. Actual records of weather do not begin until about 1730, and while tree rings do give information, it is best to refer to instrument records.

The determination of temperatures began at New Haven, Conn. in 1780 and a study of those records shows that between 1900 and 1940 there has been a two degree rise in average temperature. This rise has been world wide and now seems to have stopped. Rainfall records have been kept at Charleston, S.C. since 1732, and it has been observed that the relation of runoff to precipitation has been changing in these last 150 years.

Mr. Langbein summed up by saying that climate is variable but that instrument records available cover too short a period to determine any real change. Furthermore the details of old records are not good enough to permit accurate evaluation. It is apparent, however, that the basic climate has been fairly constant since 1900. While stream flow has been dropping off, this factor may be transient. Observations over a longer period will be necessary to determine the real trend in this direction.

New England Areas

Observations on surface water storage in New England were reported by G. W. COFFIN, Cons. Engr., Boston, Mass. Mr. Coffin said that the yield of the Boston Metropolitan Water District watershed had been recorded for many years. Records are available on the Swift and Ware Rivers. For three different reservoirs the average yield has been approximately 1.0 mgd. per sq. mi. of drainage area.

These reservoirs were built for 50 years or more and the safe yield was based on the minimum flow of the years 1880-1915. One of the factors to be considered is evaporation. In New England the records indicate an evaporation of 39.2 inches per year.

Storage Yields

Trends	Facts
C. G. Paulsen	*W. B. Langbein*
Ch. Hyd. Engr.	*Hydr. Engr.*
U.S.G.S.	*U.S.G.S.*
Washington, D.C.	*Washington, D.C.*

New York-Metropolitan

The watershed areas and reservoirs of New York City were described by Abraham Groopman, Div. Engineer, New York Bd. of Water Supply. Basically there are two reservoirs, the Croton and the Catskill. The former drains 375 sq. mi. and the latter 500 sq. mi. The Catskill system holds 150 bil. gal. of water and the Croton system holds 103 bil. gal.

For purposes of operation, these reservoirs are estimated to have only 75 per cent of actual capacity. The other 25 per cent is reserve for contingencies. On this 75 per cent basis, a 42 year record shows the Catskill system to have a safe yield of 527 mgd. and an 80 year record shows the Croton system to have a safe yield of 315 mgd. The total dependable supply is thus 842 mgd. By operating the two systems as a unit, however, the total dependable yield is increased to 888 mgd. by taking advantage of blowing the Catskill surplus into the Croton system.

Mr. Groopman said that no one should count on the last 25 per cent of a reservoir. This reserve should be kept for unknown factors, for silting allowance, for aqueduct limitations and for delayed runoff.

Also speaking on the subject of the New York City Water Supply was EDWARD J. CLARK, Chief Engr., Dept. of Water Supply, Gas, and Electricity, New York City. Mr. Clark said that the total annual draft amounted to

1015 mgd. as compared to the 888 mgd. safe yield. In the New York Supply, the first of June is the average time when drawdown of the reservoirs begins. Last year the system was overflowing on that date, but by mid-winter it was reduced to one-third of its total capacity. By means of waterless Thursdays, and many other curtailments of water use, it had been possible to reduce the daily consumption by about 300 mgd. during the winter and spring. At the time of the convention, this program coupled with

New York City

Edw. J. Clark
Ch. Engr.
Water Dept.
New York City

A. Graopman
Div. Engr.
Water Dept.
New York City

a normal rainfall, and efforts of a "rainmaker" the storage supply for New York City stood at about 87 per cent of full capacity. (In mid-June it reached about 93 per cent of capacity.)

New Jersey

In reporting on the situation in the State of New Jersey, CHAS. H. CAPEN, Chief Engineer, North Jersey Dist. Water Comm., Wanaque, N.J. said that his state had been faced with the same crises and the same catastrophes as had the New York Metropolitan area. Mr. Capen defined safe yield as the maximum dependable draft, "but," he said, "each man places his own interpretation on this definition, and hydrolicians generally allow for no factor of safety.

Mr. Capen said that for the Wanaque Reservoir he had used several methods of calculating yield including the mass diagram, the Hazen, and the Suter methods. All three gave about the same results. During 1929-32, a dry period, it was impossible to obtain enough water to equal demands. Allowing a 25 per cent factor of safety, they were able to obtain a 90 mgd. gross and an 80 mgd. net supply. (Estimates showed 85 mgd.) Interconnections to other systems were constructed to obtain the needed water. Now water is also being diverted from the Ramapo River, but the Wanaque Supply still is subject to an overdraft and Mr. Capen looks for more trouble.

In closing Mr. Capen made a strong plea for all engineers to include the factor of safety of 25 per cent in all calculations of safe yield of reservoirs.

Ohio Valley

Charles B. Burdick, Cons. Engr., Chicago, Ill., spoke particularly about siltation of reservoirs in the Ohio Valley section but did not confine his remarks to that section. On some rivers it is necessary to provide as much volume for silt storage as it is for water storage. While the east is not bothered with this problem, the mid-west, where glacial deposits exist, finds it important.

Among the factors to be considered in developing a reservoir project, are the amount of sediment, size of area, and the design of the project to handle silt. Silt storage should be expressed as per cent. It should be a rate of silting inasmuch as there is never 100 per cent silting.

The Illinois State Water Survey has studied 29 watersheds and reservoirs covering drainage areas of 1 to 10,000 sq. mi., and it was found that silt per sq. mi. is less on larger areas and that silting follows the peak of flood flows. Among the methods of preventing silting are diversion of flood flows, storage of flood waters, desilting of basins, and watershed improvement. Sometimes it may be cheaper to build a new reservoir than to desilt an old one. Floods can pick up silt if the project is designed correctly, and thus by desilting control reservoir capacity is maintained. Watershed control to reduce erosion is highly desirable. Planting of grasses aids in erosion prevention.

Mr. Burdick cited Oklahoma City as an excellent example of silt control by flood control storage whereby there results a selection of softer water for use which in turn reduces the cost of operation.

Arkansas

R. G. KINCAID, Partner, Burns and McDonnel, Cons. Engrs., Kansas City, Mo. spoke with particular reference to Little Rock, Ark. By means of slides, Mr. Kincaid showed rainfall and runoff curves and said that as long as there is an expected increase in consumption, storage will not be enough. Mr. Kincaid recommended that water supply managers should be conservative. They should have storage capacity when it is needed and that capacity should be sufficient for a drouth more severe than any on record.

Summation

Summing up the panel discussion, W. W. BRUSH, Editor, *Water Works Engineering* New York City, referred to the emphasis which had been put on the shortness of good records, which are important to the estimation of dependable yield. Mr. Brush cited E. J. Clark's comments about the effectiveness of publicity in obtaining public cooperation in water conservation. Mr. Brush also urged serious consideration of factors of safety for the things we don't know about when estimating dependable safe yield.

(The following two sessions of the Water Resources Division were reported by F. W. Kittrell, Chief, Stream Sanitation Sect., Tennessee Valley Auth., Knoxville, Tenn.)

Surface Storage

New England
Geo. W. Coffin
Cons. Engr.
Boston, Mass.

Arkansas
R. G. Kincaid
Cons. Engr.
Kansas City, Mo.

Water Use Laws

"COMMITTEE REPORT: WATER USE LAWS OF VARIOUS STATES" by Richard Hazen, Partner, Malcolm Pirnie Engineers, New York, N. Y., Chairman of the Committee on Water Use Legislation.

Mr. Hazen gave the committee's "Summary of Basic Water Use Doctrines and State Water Control Agencies." This report deals with basic underlying water law, state agencies responsible for approval of water uses, and stream pollution control legislation and administration.

The riparian doctrine, generally applicable in the 31 states east of the 97th Meridian where water is relatively plentiful, accords to each owner of land contiguous to a surface stream the right to whatever use of water he requires for domestic purposes and watering livestock and to such other use as is reasonable with regard to similar uses by other riparian owners.

The appropriation doctrine, almost exclusively applicable in the 17 states west of the 97th Meridian where water is relatively scarce, gives to the first user of water from a surface stream the right to continue his use so long as it is beneficial, even to the extent of appropriating the entire supply if necessary for the established use. Any surplus is available for subsequent appropriators in order of time of making their appropriations.

Three primary doctrines govern ground water use. The English or common law rule recognizes ownership of subsurface water by the owner of overlying land and places no restriction on the owner in his use of such waters. The American rule of reasonable use limits the owner of overlying land to such use of subsurface waters as is reasonable with regard to similar rights of other owners of land overlying the same source. The doctrine of appropriation recognizes public ownership of subsurface waters, which are subject to appropriation for beneficial uses in the same manner as surface waters.

Surface Storage

Ohio Valley
C. B. Burdick
Cons. Engr.
Chicago, Ill.

New Jersey
C. H. Capen
Ch. Engr.
No. Jer. Wat. Comm.
Wanaque, N. J.

In most states the state health department, in addition to jurisdiction over public water supplies, has considerable authority, directly or indirectly, over the whole range of water supply development, including matters which may not be related to public health. There is a growing tendency, particularly in the eastern states, toward creation of pollution control agencies having representatives of conservation, recreation and industrial interest in addition to health departments. Jurisdiction applicable to public water supplies frequently does not apply to private developments such as those for industrial plants, where health department control generally covers drinking water and waste disposal but not process water.

Twenty-nine of the 48 states have agencies with some control over use of surface waters, 13 have no control agency, and 6 have agencies with advisory responsibilities. Twenty-six states have control agencies for ground water use, 18 have no control agency, and 4 have advisory agencies. The state health departments exercise control in about half of the 43 states having definite laws for controlling pollution.

An interesting recent development is the growth of interstate compacts and agreements for control and development of water resources. Thirty-three states are parties to compacts or agreements. In the western states compacts are concerned primarily with division of available water. In eastern states compacts deal principally with water pollution. The Federal Water Pollution Control Act of 1948 is designed to control pollution of interstate waters.

California's Laws

"California Water Pollution Control Laws" by L. W. Grayson, Supt., Electric Light and Water Dept., Riverside, Calif.

Mr. Grayson described the laws and activities leading to their adoption. The need for revised legislation was recognized in 1947 when the legislature created an interim fact-finding committee. Water works operators of the states presented a petition to the legislature requesting protection of water sources against pollution. Eleven bills were introduced during the 1949 legislative session. The California Section of AWWA was active in opposing the Dickey bill as drawn in the senate, urging its defeat as dangerous legislation that would endanger public water supplies and the public health, jeopardize industrial supplies, and fail to protect agricultural uses.

In all some dozen cooperating groups interested in reasonable water use opposed the Dickey bill and supported the bill which became the present pollution control law. This defines water pollution as that which interferes with reasonable use, and water contamination as that which endangers public health. It establishes a state Water Pollution Control Board, but also recognizes and provides for municipal and local rights through the establishment of nine regional boards, which receive advice from the State Board. The State Board has thirteen members and the regional boards have five members, representing water supply, irrigation, waste-producing industry, county and city interests. The State Board investigates pollution problems, prepares long range abatement plans, issues orders for correction of pollution and brings court action where necessary. The State Department of Public Health is responsible for control of contamination that endangers public health. State loans for waste disposal facilities are available to municipalities up to the full value of the project. A Committee on Water Quality of the Water Pollution Control Board has completed its report on water quality in the short time since the Board was organized and progress is being made on other reports.

Legislation in Congress

"Review of Pending Water Resources Legislation in Congress," by G. E. Ferguson, Staff Officer to Chief Hydraulic Engineer, U. S. Geological Survey, Washington, D. C.

Mr. Ferguson classified the bills under six major headings, according to the principal water resources subject involved in each bill. *Production* of water was the subject of a number of bills which dealt with production of fresh water from sea water, and with induced precipitation. Two stressed national security and assigned responsibility to the Navy, which did much work on sea water utilization during the war. Four gave responsibility to the Department of the Interior. All provided for research funds, with the range of appropriations between $500,000 and $50 million. The single bill in the Senate received most attention. It cited overuse of ground water as justification for investigation of use of sea water, directed examination of the economy of methods of distribution and sale, and was amended to include investigation of induced precipitation as well as use of sea water. It was referred to committee.

Water Use Laws

Comm. Report
Rich. Hazen
Partner
M. Pirnie Engrs.
New York City

Congressional
G. E. Ferguson
Staff Officer
U.S.G.S.
Washington, D.C.

Investigation included one bill for preparation of a comprehensive resource development plan for full use of the nation's water resources, with particular emphasis on subterranean waters of the west. The bill provided for a Water Conservation Bureau, with participation in the investigation by the U. S. Geological Survey and the Weather Bureau. Bills establishing commissions to investigate conservation of land and water resources in the Arkansas and White River Basins, and in the New England states were included, by amendment, in the Rivers and Harbors Bill. In signing this Act the President objected to the inclusion of bills of this type. A Senate Resolution called for study of water resources in several California counties. Another bill, of interest to

water and sewage works men, authorized the Department of Agriculture to study control of aquatic plants.

Appropriation bills dealt with Congressional consent to compacts, including the Upper Colorado, Arkansas, Pecos, Snake, Canadian and Cheyenne Rivers. One provided for allocation of Colorado River between Arizona and California, and included a joinder by the Senate requiring that the rights of Arizona and California to Colorado River water be brought to test in the U. S. Supreme Court.

Development included the Rivers and Harbors Bill, as well as several lesser bills. One authorized the Chief Engineer of the Crops of Engineers and the Secretary of Agriculture to survey water resources of New England streams and of the Arkansas, White and Red Rivers, covering domestic and municipal water supplies. Two bills provided for extension of studies of water storage in arid states to other sections of the country, and a third for studies of diversion of surplus water in the area west of the 98th Meridian. Another made provisions for deducting costs of land and water development from income taxes. One provided for a five year program of studying development of water resources in national forests by the Secretary of Agriculture.

Protection bills dealt with stream sanitation. Several proposed changes in Public Law 845, the Federal Pollution Control Act, including liberalization of financing, provision of construction loans to industries, elimination of hearings, authorization of funds for research, and extension of more authority to the states.

Administration bills were concerned with establishment of river basin authorities. Several called for a Columbia Valley Authority and a Missouri Valley Authority. Another provided for a Connecticut Valley Administration. Only speculation is possible regarding many of these bills. Many will die in this session of Congress, but many will be reintroduced in future sessions. The 81st Congress apparently has been quite water conscious.

Ground Water Prospecting

The panel discussion, "Prospecting for Ground Water," dealt with geological and geophysical methods for locating ground water, sampling methods for earth and water testing, test pumping methods, and calculated predications of yields.

"Geological Methods" by R. M. Leggette, Consulting Ground Water Geologist, New York, N. Y.

This paper which was read by C. A. Bays pointed out that geology controls both quantity and quality of ground water. Much basic geological information is available for preliminary consideration, which usually is followed by a field survey and sometimes by test drilling in planning development of ground water. Knowledge of underground rock formation will assist in predicting probable yields and mineralization of the ground water, and the prospect for obtaining adequate and usable water. Industries have wasted money in drilling wells where the geology involved indicated slight chance of success. On the other hand, costly surface water development has been undertaken where the geology indicated the probable existence of ground water that could be developed more economically.

Ground Water

J. J. Baffa
Cons. Engr.
New York City

Wat. Res. Div. Plans

F. W. Kittrell
Chief, Stv. San.
Sect., TVA
Knoxville, Tenn.

Geophysical Methods

"Geophysical Methods" by Carl A. Bays, Pres., Carl A. Bays and Associates, Inc., Urbana, Ill.

According to Mr. Bays geophysical methods can not replace geologic, hydrologic, and other long established methods, but are useful as supplementary methods. They are successful only where distinct differences in physical characteristics of underground formations occur. At present they can be used most economically only when tailor-made instruments and techniques are patterned to the requirements of the particular situation involved.

The newest geophysical tool is radioactivity. In a few cases variations in natural radioactivity of underground formations occur and may be measured in defining the various formations. Gamma ray tracers may be used for the same purpose.

Occasionally differences in density may be measured to outline dense, heavy rock deposits. Seismic methods utilize differences in transmission, reflection or refraction of rays. These are used mainly in prospecting for oil, and oil field seismographs, made for deep prospecting, are not well adapted for relatively shallow water prospecting.

Magnetic and electro-magnetic methods have relatively little application, being most useful for defining hidden terrain in geological surveys. Electrical conductivity methods involve measurement of both potential and resistance, with the latter more widely used for ground water prospecting. It is useful for determining the boundary between two types of rock and defining the surface of a particular type of stratum, such as sand and gravel. Geothermal methods may find occasional use, but are rarely applicable.

Test Well Drilling

"Test Drilling" by T. W. Thorpe, Pres. and Gen. Man., Thorpe Well Co., Des Moines, Iowa.

Mr. Thorpe pointed out the difficulties of obtaining representative samples and the dangers of contamination from previously drilled upper strata. Samples usually must be taken from deep aquifers, where sampling difficulties are greatest, since shallow wells usually are unsatisfactory. Either suction or plunger bailing yields best results in unconsolidated formations. The bailer must fit the casing properly. A section of slotted casing may be used for water samples. A rotary sampler has decided advantages in deep, sandy formations if some contamination of the samples from upper strata is not important.

Deep testing in creviced rock is difficult, since water originally present in the crevices tends to move out into and mix with the fresh water in the well. When the first water is encountered, test samples should be collected and static head and drawdown measured. Subsequent drilling may cause the head to rise as a deeper aquifer is penetrated and a balance between the heads of the two aquifers is reached. In some cases adequate samples may be obtained by bailing, but in others it may be necessary to case off the upper aquifer, and seal with cement. Following completion of sampling the casing and cement must be drilled out to permit continuation of drilling at the same diameter. Regardless of adverse conditions encountered, proper equipment backed by sound knowledge and experience will assure the collection of reliable samples, that will permit selection of the level from which the best water can be obtained.

Pumping Tests

"Pumping Tests" by J. G. Ferris, Dist. Eng., Ground Water Branch, U. S. Geol. Survey, Washington, D. C.

Mr. Ferris described some of the variations possible in objectives and

methods of pump testing. Such a wide variety of methods is possible that any degree of accuracy may result. The rate of pumping may be constant, constantly varying, or fluctuating. A constant rate is preferable, and if the rate must be changed it should be in steps, with adequate data at each step to permit reliable extrapolations to ultimate drawdowns and yields. Wide open pumping is not good practice and does not yield reliable results.

The test period should be long enough to determine the effect on all wells in the same aquifer up to a distance of several miles. Accurate measurement of drawdown is essential, since a few feet of error may result in a large error in estimating yield. Accurate measurements may not be possible during pumping due to surging and splashing, the best measure being obtained on recovery of level from pumping.

A small observation well should yield at least five gallons per minute and should return to level in one minute or less. The desirable pattern of observation wells was described in some detail. The cone of drawdown follows a logarithmic rate and drawdown observations preferably should be spaced at logarithmic periods of time. Accepted methods of analyzing test data, involving knowledge of geology and hydrology, give accurate predictions of yields.

Summation

J. J. Baffa, Consulting Engineer, New York, N. Y., reviewed the major points of previous papers of the panel, particularly those involving predictions of yields and conservation of ground water resources. Emphasis was placed on the amazing accuracy with which predictions of yields can be made in the face of many unseen and unknown underground factors, using only a hole in the ground, test data, and a sound knowledge of meteorology, geology, and hydrology.

The factors involved in conservation were described in terms of a bank balance, illustrating the dynamic balance maintained in nature. Income is represented by precipitation and percolation, or recharge, cash on hand by underground storage, withdrawals by evaporation, transpiration, seepage to the surface and use, with deficits resulting from excessive use and in some cases from pollution and intrusion. There are many possibilities of safe utilization without creation of a deficit, but reliable bookkeeping to maintain a safe balance requires intelligent application of sound statistical methods to all available data.

Meteorological data are important in predicting future safe yields when correlated with factors of terrain and geology to estimate anticipated income, since these govern percolation and runoff and determine receivable assets. TVA multipurpose reservoir operations, based on long range predictions of precipitation and runoff, provide an outstanding example of utilization of these methods. The U. S. Geological Survey provides invaluable information on availability of water resources.

Plugging Old Wells

J. C. Harding
Comm. Pub. Wks.
Westchester Co.,
White Plains, N.Y.

O. J. Muegge
San. Engr.
State H'lth Dept.
Madison, Wis.

Military Supplies

Sherwin F. Kelly, Pres., Sherwin F. Kelly Geophysical Services, Inc., Wilmington, Del., and of Geophysical Explorations Ltd., Toronto, Ont., Can., in an added paper, gave the experiences of a water prospecting unit of the British Armed Forces in locating ground water for military purposes during the last war. The outfit consisted of three field parties, under the direction of geologists, two of whom had special training in geophysical methods. In five years they operated from Kenya to India, covering all types of terrain from tropical forests and deserts to snow covered mountains and encountering all types of geology. Possibly the most extreme situation in which ground water was located was in a desert with a precipitation record of one centimeter of water in two years. Water was located in about seventy per cent of the sites recommended by the outfit.

Plugging Abandoned Wells

James C. Harding, Commissioner, Westchester County Dept. of Public Works, White Plains, N. Y., and Co-chairman of the Committee on Deep Wells and Deep Well Pumps, reported that his committee had just gotten started on preparation of specifications for "Plugging Abandoned Wells." He expected the preparation of specifications to be relatively simple, but sought suggestions on how plugging of abandoned wells might be enforced since many would be unwilling to spend money on exhausted wells from which there would be no return.

In conjunction with this committee report O. J. Muegge, Sanitary Engineer, State Board of Health, Madison, Wisconsin, presented a discussion on plugging abandoned wells. Public interest in the subject has been aroused by the tragic death of Kathy Fiscus in an abandoned well in California. An even more important reason for attention to the subject is the danger of epidemics due to pollution of aquifers, in which there are active wells, through open abandoned wells. The public soon forgets epidemics traceable to this cause, but it is a matter for real concern to the water works profession.

Proper sealing of wells depends on the geology, type of well construction and hydrostatic head involved. Abandoned wells should be filled completely with concrete where possible. Casings and obstructions should be removed. Large, deep wells may require other materials than concrete for economy. Fine sand in the bottom and clay in the top of large wells may be satisfactory. Limestone and other creviced formations require concrete to seal crevices. Alternate concrete and clay layers may be acceptable. Legislation is needed to support programs for plugging abandoned wells.

Water Resources Division Plans

F. W. Kittrell, Chief, Stream Sanitation Section, Tennessee Valley Authority, Knoxville, Tennessee, Chairman of the Water Resources Division Planning Committee, reported on activities of the committee. During the year it had suggested subjects and speakers for the present annual conference, prepared a catalog of subjects it considered of proper interest to the Division to serve as a framework for organization of Division committees, and analyzed the subjects of water resources papers given at AWWA section meetings during the period 1945-1949 to determine the order of interest in water resources subjects exhibited by the water works profession.

Ten per cent of all papers dealt with water resources subjects in 1945-1946 and 15 per cent in 1947-1949. Investigation of water resources, including location, measurement and determination of quality demanded the greatest interest, accounting for 27.9 per cent of all water resources papers. Water resources development was second with 22.3 per cent. Rather surprisingly, sewage and industrial waste disposal was third with 21.0 per cent, and stream sanitation fourth with 14.6

per cent. If sewage and industrial waste disposal and stream sanitation were combined, which they logically might be, they accounted for more than a third of all water resources subjects. Conservation measures, other than stream sanitation, placed fifth at 8.2 per cent. Legislation was sixth accounting for 3.4 per cent. Precipitation was in last place with only 2.6 per cent. An analysis was made of interests exhibited by various sections of the country, but time did not permit discussion of the findings.

W. H. Cates
Mgr.
Hydr. Div.
Cons. West Steel Co.
Los Angeles, Calif.

G. E. Burnett,
Head
Paint Lab.
Bur. of Reclamation
Denver, Colo.

F. E. Seaman
Res. Engr.
Res. Laboratory
Lock Joint Pipe Co.
Wharton, N. J.

Pipe Design

Pipe Design

One session of the AWWA Convention was devoted to the topic of "Pipe Design." First on the program was R. E. Barnard, Advisory Engr., Spiral Welded Pipe Dept., Armco Drainage and Metal Products, Inc., Middletown, Ohio. Mr. Barnard spoke on the "Design of Steel Plate Pipe Flanges" and illustrated his paper with many diagrams of flanges.

H. F. Kennison, Chief Engr., Lock Joint Pipe Co., East Orange, N. J., read a paper on the "Design of Prestressed Concrete Cylinder Pipe" in which he described the construction of the pipe, its design features and the tests made.

W. H. Cates, Mgr., Hydraulics Div., Consolidated Western Steel Corp., Los Angeles, Calif. gave a paper on "Design Standard for Large Steel Water Pipe." Mr. Cates said that his paper was a part of the specifications for such pipe as developed by the AWWA Committee in the past ten years. These design standards are based on 25 years of experience.

F. E. Seaman, Research Engr., Lock Joint Pipe Co., Wharton, N.J. discussed "Tests of Prestressed Concrete Steel Cylinder Pipe." These tests include tests of the materials used, including the steel wire, hydrostatic tests, beam tests, and others.

G. E. Burnett, Head, Paint Lab., Bureau of Reclamation, Denver Federal Center, Denver, Colo. concluded the session with a paper on "Performance of Coal-Tar Enamel on Steel Water Pipe and Penstocks." Mr. Burnett's observations were based on installations of pipe from the Panama Canal Zone to temperatures of minus 43 deg., F.

If coal tar enamel is properly applied and installed, it will give permanent protection according to Mr. Burnett. There are some limitations which must be considered: Shock from exposure to cold temperatures, thin wall pipe at cold temperatures adds to the cracking problem of enamel, and the melting point of the enamel must be high enough to prevent sagging. Outside coatings should also be given consideration. In many locations cathodic protection is the answer and where tests indicate the need for cathodic protection, then its use together with coal tar enamel "insures protection forever."

Big Sampling Program for Ohio River

The Ohio River Compact Commission has laid plans for a 900-mile water-quality investigation.

Representatives from six states, the U. S. Corps of Engineers and the U. S. Geological Survey met with the Commission staff in August for final orientation on the procedures to be used in sampling program that was conducted simultaneously from 32 stations on the Ohio River. Samples and analysis were made around-the-clock during the two-week period in September.

"Purpose of the investigation", explained Henry Ward, chairman of the Commission, "is to determine the quality of the water in the Ohio River, at its principal tributaries and near major sources of pollution. We want to know what the condition of the river is for yardstick purposes in evaluating clean-up progress. And we want to find out precisely where the worse conditions are in order to focus attention on places where corrective measures must be expedited".

To insure that all laboratory results were comparable, state personnel received special instruction in techniques at a seminar conducted by the USPHS in Cincinnati.

Second Lap of G.E.'s "More Power To America Special"

The "More Power to America Special," the General Electric Company's mammoth mobile showcase of electric products for industry, headed west from Schenectady September 5 on the second lap of its nationwide tour.

The ten-car exhibit train will visit 29 key midwestern industrial centers this fall before swinging south, down the Atlantic coast.

During its midwestern tour, the "Special's" cargo of exhibits of modern products and systems for producing, distributing and using electric power will be inspected by an estimated 35,000 industry leaders.

The train, which has been called "the most important single promotional undertaking in the Apparatus Department's history," has been in "drydock" for routine maintenance and cleaning since completing its spring tour of New York and New England.

Many of the train's hundreds of exhibits have been renovated or replaced "in order to keep the electrical display completely up to date."

During its first two months on the rails, the "special" traveled 1,982 miles in visiting 20 cities in New York and New England. Almost 33,000 invited industry, electric utility and government representatives toured its quarter-mile-long "tunnel" of displays.

By the end of its trip across the country in 1951, the streamliner will have visited 150 industry centers and been inspected by approximately 200,000 leaders of industry.

Because the exhibits aboard the train were designed especially to interest those concerned with the generation and industrial application of electricity, the train will not be open to the general public. Attendance will be limited to invited representatives of electric utilities, the manufacturing and transportation industries, the armed services, the federal government and municipalities.

[Ed. Note: This unique "show room on wheels" was the subject of a special illustrated preview article in W. & S.W. for June 1950.]

THE DROP-COUNT SYSTEM OF WATER ANALYSIS

by
CLIFFORD C. HACH
HACH CHEMICAL CO.
AMES, IOWA

IN THE commercial testing of water for its various components, such as hardness, alkalinity, chlorides, sulfates, iron, carbonates, hydrogen sulfide and other substances, an absolute testing accuracy of 5 percent is generally sufficient. Many of the analytical procedures themselves give results which are no more accurate than this.

The Drop-Count principle of water testing has been used for years, though in the past this system has given undependable results. In order to provide testing equipment at a very low cost, yet accurate enough for nearly all practical purposes, the Drop-Count system has been greatly improved. Standard test procedures are employed, but instead of using a burette to titrate the water sample, an accurately standardized dropper is used. Droppers that deliver one-tenth of a milliliter per drop, with an accuracy of five percent are used to dispense the titrating solutions.

Dropper Tips

A thorough study has been made on the design and operation of dropper tips, and a design has been developed that meets the following specifications:

Fig 1—Versenate Hardness Tester

(1) The droppers consistently deliver 0.10 ml. (plus or minus 0.005 ml.).

(2) The droppers will give the correct size of drops immediately upon being put into service—no preliminary cleaning and conditioning (wetting) treatment is necessary.

(3) The angle at which the dropper is held has a negligible effect upon the amount delivered.

(4) The drop size is substantially constant regardless of the rate that the drops are dispensed.

(5) The dropper tubes are mass produced.

Ordinary droppers vary widely in physical dimensions as well as in performance. The most common type dropper is made with a drawnout tip. The drop-size obtained from this type of dropper is affected greatly by the angle at which the dropper is held and the tips are not uniform in size. Another common commercial type has a blunt round tip, and the greatest trouble with this type is reproducibility.

At the present time there are drop-count water hardness testers on the market which employ ordinary commercial dropper tubes. One of these testers was recently tried out and it gave values 30 percent low when the dropper was held in a vertical position and 50 percent low when the dropper tube was inclined at 45 degrees. Such inaccurate testers have given a bad name to the drop-count system.

Drop-Count water hardness testers using the standard 0.1 ml. droppers are being successfully used by salesmen of domestic water softening equipment, as well as in smaller municipal water treatment plants. Small testers are being used successfully by plumbers and householders in connection with the maintenance of domestic water softeners. Figure 1 illustrates a Versenate Hardness tester. The simplicity of its operation can be judged by the following directions which apply to this instrument.

Directions:

1. Fill the small test tube full of the water to be tested and pour it into the mixing bottle.
2. Add one full measure of powder from bottle two.
3. Add solution 3 dropwise while the drops are counted, until the color of the solution changes from red to blue. The hardness of the water in grains per gallon is equal to the number of drops used.

Following is a table of results for the hardness of water obtained by different persons with the Versenate Hardness test using a Model No. 5 Drop-Count Tester. None of the persons had ever seen the test before.

True Tot. Hard. (Grains per gal.)	A			B			C		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
5.0	4-5	5	4-5	5	5-6	5	5	5	5
20.0	19	21	20	21	21	20	20	20	21
58.3	57	60	57	59	59	57	58	58	57

These data shows that consistent and accurate results are obtained by different persons, even though none was practiced.

This system has been applied to the determination of total hardness by the Versenate Method, alkalinity, iron, hydrogen sulfide, carbon dioxide and chloride. Figure 2 illustrates a Drop-Count hardness and iron combination tester.

Fig. 2—Combination Drop-Count hardness and iron tester.

OHIO SEWAGE & INDUSTRIAL WASTE TREATMENT CONFERENCE

IT was the twenty-fourth annual meeting of the Ohio Sewage and Industrial Waste Treatment Conference; it was held at the Gibson Hotel in Cincinnati on June 28-29-30; and it was a huge success. Two hundred fifty-eight persons registered, including 44 women, and 195 persons attended the banquet; the largest in the history of the organization.

Presidents

Incoming	Outgoing
H. S. Kline	*Robt. Bowman*
Ind. Engr.	*Supt.*
Frigidaire, Inc.	*Water & Sewage*
Dayton, Ohio	*Newark, Ohio*

Business Session

The report of the Secretary-Treasurer showed a membership of 229 prior to the conference registration and there were a number of new additions during the conference. New officers elected for the ensuing year were:

President
Hubert S. Kline
Industrial Engineer
Fridigaire Div.
General Motors Corp.
Dayton, Ohio

1st Vice President
Walter E. Gerdel
Superintendent
Southerly Sewage Plant
Cleveland, Ohio

2nd Vice President
D. G. Stevens
Chief Engineer
Tech. Service Div.
Standard Oil Co.
Cleveland, Ohio

Secretary-Treasurer
Earl Richards
Engineer
Ohio Dept. of Health
Columbus, Ohio

Al Hall, Engr., State Dept. of Health, was forced, by pressure of work, to relinquish the office of Secretary-Treasurer which he has filled for a number of years.

Instrumentation

The opening session consisted of a two member manufacturers' forum on the subject of "Instrumentation as an Aid to Plant Operation." This session was presided over by Hubert S. Kline, incoming president of the organization.

"APPLICATION OF MEASUREMENT AND CONTROL TO INDUSTRIAL WASTES," by Dr. W. N. Greer, Technical Staff, Leeds & Northrup, Philadelphia, Pa.

Dr. Greer pointed out that continuous recording of pH for automatic pH control had but one problem, that of suspended matter collecting in the electrodes. To offset this problem, Dr. Greer showed two new types of pH cells for use in the control of industrial wastes. One of these is a plastic cell and the other a unit for immersion in the sewer itself.

According to Dr. Greer there are a number of factors which affect automatic pH control. Among these are the following:

1. Flow rate and rate of change of flow rate
2. Total acidity and rate of change of acidity concentration
3. Retention time in treating system, and the distribution of that retention time; i.e., the relation of total capacity to rate of flow
4. pH control point or range desired
5. Agitation in treatment tank
6. Time interval between control and measurement; i.e. detection lag (should not exceed 1 min.)
7. Rangeability of feeding device

Dr. Greer spoke of the use of high magnesia lime which has a slow reaction time and thereby imposes a control problem. He also discussed the use of several tanks in which stepwise control or neutralization is carried out. There are several advantages in the use of immersion electrodes, because, among other things, pumping of samples is avoided. On the other hand, float type electrodes can be located better, but care should be taken that suspended solids cause no problem.

Dinner Speaker
Wm. A. Hessler, Feature Writer Cincinnati Enquirer, stands by model of Cincinnati's Little Miami Sewage Works

In the discussion from the floor, L. L. Hedgepeth, Consultant, American Cyanimid Co., Bound Brook, N.J., stated that in many instances he had found the use of high magnesia lime was preferential because a stable effluent could be produced whereby a high calcium lime would produce an unstable effluent.

1st Vice Pres.
Walt. E. Gerdel
Supt.
Southerly Plant
Cleveland, Ohio

Retiring Secy.
G. A. Hall
Engr.
State H'lth Dept.
Columbus, Ohio

(We regret we have no pictures of D. G. Stevens, 2nd V.P. and Earl Richards, new Secretary)

PRIMARY DEVICES AND METERS FOR WASTE FLOW MEASUREMENT," by H. C. Hite, Engineering Dept., Brown Instrument Div., Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.

In discussing his subject, Mr. Hite pointed out that there are two conditions under which flow measurements may be made, one in filled pipes and the other in open channels. For measurement in the former there are the differential head meters; i. e., Venturi tube, orifice plate, flow nozzle, and pitot tube. For the latter case, there are the head area meters, as for example, the weirs and the Parshall Flume.

Mr. Hite then proceeded to describe each of these measuring devices and to explain the principles of operation of each and the advantages and disadvantages of each. These he summed up in a table showing the various properties and how the orifice, Venturi tube, and flow nozzle compared as to each of these properties.

Mr. Hite's presentation also covered the secondary measuring devices, the meters and recorders, and how they work. Included in this part of the discussion were recording and integrating meters, pneumatic and electric transmission, and how these meters work off of the primary unit.

At the afternoon session of the first day, an address of welcome to the City

of Cincinnati was delivered by the Hon. Albert D. Cash, Mayor of Cincinnati. This session was also devoted to the business of the conference, and reports of sectional conferences as well as three papers of technical significance and an important talk on the Federation of Sewage Works Assns.

(The following four sessions were reported by D. D. Heffelfinger, Engr.-Supt., Dept. of Water and Sewage, Alliance, Ohio.)

"A More Productive Federation," by W. H. Wisely, Executive Secretary, Federation of Sewage Works Associations, Champaign, Ill.

Programmers

W. H. Wisely
Exec. Secy.
Fed. Sew. Wks. Assn.
Champaign, Ill.

F. C. Tolles
Associate
Havens & Emerson
Cleveland, Ohio

Mr. Wisely briefly traced the history of the Federation from its beginning as only a journal publisher to the varied activities of the present time. This year the Journal has been published monthly, increasing the quantity of material 40% while maintaining the previous high quality, and while it was necessary to increase the dues practically no loss in membership has resulted. A plea was made to plant operators for practical operating material for the "Operators Corner."

The tremendous activity in the industrial waste treatment field was described and the efforts of the Federation to meet the needs arising, including the change in the name of the Federation to include industrial wastes. Mr. Wisely discussed the Federation manuals, the 20 year index to the Journal to be published in September and the work of the Federation as a partner in the preparation of the 10th edition of the Standard Methods.

Mr. Wisely concluded by stressing the value of the member associations and extending an invitation to the Federation meeting in October in Washington, D.C.

Sectional Conferences

North East—Sam Ake, Bedford. Mr. Ake reported a very active section, with an average attendance of over 90. Meetings were varied, 2 held at various plants and 2 including inspection trips of chlorine and other industrial plants.

North West—Elmer Pollex, Toledo. Mr. Pollex discussed the history of this the oldest of the sectional conferences which was started in 1937 and has had an average attendance of 30. Four meetings are held annually with inspections of two industrial plants slated for the next 2 meetings.

Central—W. D. Sheets, Columbus. Four meetings are held annually in the Central conference. Since all of the Sewage Plants in the area have been visited, all meetings are now being held in Columbus.

South West—Resler Calihan, Dayton. Five meetings were held last year including one at Wilberforce University, and one for the inspection of the Health Department mobile trailer laboratory which was stationed in the area last summer.

Eastern—No report.

Program for Cincinnati

"Features of Little Miami Sewage Works," by F. C. Tolles, Havens and Emmerson, Cleveland, Ohio.

Mr. Tolles presented the overall plan of sewage treatment in the Cincinnati area. The City of Cincinnati and 21 surrounding communities having a total area of 214 square miles, 20 miles of frontage on the Ohio River and extending 14 miles inland, have united to attempt to solve their disposal problems. The area has been divided into four drainage districts, and the treatment facilities for the first of these districts to be started are at the Little Miami Sewage Works.

Problems confronting the engineers were: the public relations program necessary to sell the project to the citizens of the various communities, arriving at an adequate method of financing, the adopting of industrial waste ordinances, and adapting of the entire plan to the regulations of the Ohio River Valley Sanitary Commission.

The Little Miami Treatment Works was designed for a population of 132,000 and a flow of 22 mgd. Partial treatment, with chemical pre-flocculation during low river stages and chlorination are being provided, along with sludge filtration and incineration. Contracts let to-date total 4½ million dollars.

"Methods of Financing Sewage Disposal Program in Cincinnati" by A. B. Backherms, City Sewerage Engineer, Cincinnati.

Mr. Backherms discussed the long and tedious efforts made in an endeavor to arrive at an adequate method of financing which would be suitable to all of the 22 communities involved. Finally in December, 1948, a sewer rental plan was adopted which consisted of a base rate of 6 cents per 100 cubic feet of water used up to 60,000 cubic feet monthly and a graduated scale from this point. This rate was adopted by all the communities involved, paving the way for the start of the construction program.

The entire project which includes the construction of four sewage treatment plants was estimated at 19 million dollars in 1940, with present day estimates at 30 to 35 million dollars. The construction program will be spread over a ten year period and construction will be undertaken each year in accordance with the amount of money available from the sewer rental charge. Part of the revenue must be used for debt service and another portion for operation and maintenance.

Instrumentation

Dr. W. N. Greer
Tech. Staff
Leeds-Northrup
Philadelphia, Pa.

H. C. Hite
Engr. Dept.
Brown Instr. Co.
Philadelphia, Pa.

"Program on the Kentucky Side of the River" by Al Seaman, Vogt, Ivers and Seaman, Consulting Engineers.

Mr. Seaman discussed the pollution picture on the Kentucky side of the Ohio River. Surveys have shown that all of the outfall sewers are concentrated along the Ohio and Licking Rivers and that it is possible for the wastes from all of the communities to be discharged below the urban populations on the Kentucky side.

Legislation has been adopted by Kentucky, backing up that State's participation in the Ohio River Valley Sanitation Compact, providing for the creation of sanitary districts and means for financing construction and operation of treatment plans. The Northern Kentucky Sanitary District has been established which will include 145,000 persons of the 160,000 in the two counties opposite Cincinnati. Sewer rental based on water consumption has been set up.

The plans of the treatment plant, which will give primary treatment during normal flows with chemical precipitation during low flows, have been approved by the Kentucky Health Department and construction is expected to be started in 1951 and completed in 1952.

Operators' Forum

The Operators Forum was conducted by Lloyd Huffman, Director of Water & Sewage, Dayton, Ohio, and consisted of four parts.

1. *Trickling Filter Media Clogging*—Walter Gerdel, Cleveland, Leader. Discussion of this topic brought remarks to the effect that where clogging was due primarily to organic material, chlorination and washing were effective in eliminating clogging, but where clogging was due to inorganic matter, such as dirt, grit and ash, the only answer was the removal and replacing of the media.
2. *Mineral Oils and Greases*—Art Niles, Toledo, Leader. This discussion concluded that although preaeration with chlorine was not always effective, it was the best method available. The best answer to the problem was to control the oils and greases gaining access to the sewer system.
3. *Aluminum Paint*—A representative of Sherwin-Williams discussed aluminum paints, noting the wide varieties and grades

Cincinnati Problems
A. B. Bachherms
City Sew. Eng.
Cincinnati
Ohio

Operators' Forum
Lloyd Huffman
Director
Dept. Wat. & Sew.
Dayton, O.

of aluminum powders and vehicles available. Proper choice of these must be made according to the specific properties desired in the paint.

4. *Sewer Ordinances*—Don Bloodgood, Purdue Univ., Leader. Controlling the types of wastes discharged to the sewer system and setting certain limits for temperature, pH, B.O.D., etc., were discussed. The Federation Manual containing a model sewer ordinance is an excellent guide.

FWPCAB

"Activities of Federal Water Pollution Control Advisory Board" by L. A. Danse, Supervisor, Materials and Processes, Production Engineering Section, G.M.C., Detroit, Mich.

Mr. Danse who is a member of the Fed. Wat. Poll. Cont. Adv. Bd., described Public Law 845 passed by the Federal Government in 1948, and establishing the Water Pollution Control Advisory Board. Although no money was appropriated for this board, and many said that the law had no teeth, it was found that by working through the press, largely the out-door writers, it was possible to exert a great amount of influence, and much has been accomplished in this manner.

Mr. Danse called for action from all parties concerned. The time for stalling is past. In the midwest, industry is ahead of municipalities in solving their pollution problems; in some other parts of the country industry is lagging.

Stream Quality Objectives

"Stream Quality Objectives" by Maurice Le Bosquet, Jr., Director of Field Activities, Public Health Service, Cincinnati, Ohio.

Mr. Le Bosquet discussed the development of stream quality objectives for the Ohio River Valley. The objectives will depend upon the stream usage and different classifications are being set up for certain stretches of each stream, since no overall standard to be applied to all cases is feasible or desirable. The objectives should not be higher than is necessary to accomplish the aims, so as to not unnecessarily burden either the municipalities or industry. Even less than the desired objectives may be accepted in some cases pending certain technological advancements.

The objectives set for certain stretches of a stream are to be primary requirements and not subject to much change. Quality requirements for individual effluents will be established to reach the primary objectives, and these effluent requirements may be revised from time to time due to growth, etc. Analytical methods for determining polluting substances will be a part of any standards adopted. A minimum removal of 45% of suspended solids has been adopted for the entire Ohio River Valley.

While critical low flows will determine the design of treatment plants, it is felt that it is uneconomical to design for the lowest stream flow on record, and consideration must be given in any design to the consequences of failure to meet the objectives during short periods of time.

Discussion by F. H. Waring, Chief Engineer, State Department of Health, Columbus, Ohio.

Mr. Waring emphasized that stream pollution control is a state responsibility and is recognized as such in the Federal Act. Ohio recognizes that each stream must be treated individually as to time of construction and degree of treatment. Water quality objectives will be set up at many places along a stream and will depend upon the use to which the water is put. Streams will be studied during low flows and zones of water quality set up. The Miami River was chosen for the first survey because of the concentrations of pollution needing immediate action, and to cooperate with the Ohio River Compact.

Tentative standards of 65% B.O.D. removal have been set up for the three main cities in the Miami River Valley. Cincinnati has been waiting for the requirements to be established by Ohio and the Ohio River Compact.

Stream Standards
M. Le Bosquet, Jr.
Director
Field Activities
USPHS
Cincinnati, O.

F. H. Waring
Ch. Engr.
Div. San. Engr.
State H'lth Dept.
Columbus, O.

Mobile Lab.
Bruce McDill
Engr. in Chg.
Wat. Poll. Cont.
Columbus, O.

Welfare Inst.
E. F. Wittwer
San. Engr.
St. Welfare Dept.
Columbus, O.

The Cuyahoga and Mahoning watersheds will be surveyed next.

Mobile Laboratory

"Water Pollution Mobile Laboratory Operation" by Bruce M. McDill, Engineer, Water Pollution Control, Ohio Department of Health.

Mr. McDill described the trailer laboratory recently acquired by the Ohio Health Department and the stream pollution work that is being done. The trailer lab is pulled with a station wagon and has a crew of 5 assistant engineers and aids. In 1949 thirteen special problems involving industrial wastes, and one complete watershed sanitary survey were made which involved the collection and analysis of 581 stream samples, 244 municipal sewage samples and 208 samples of industrial wastes.

The data obtained from stream analyses must be correlated to low stream flows and allowance made for natural stream purification. It is basic that streams should be used for the disposal of industrial wastes and municipal sewage as long as consistent with the health, welfare and economics of the users of the stream.

Mr. McDill described the complete survey of the Miami River and the quality objectives for critical low flows in the river which were recommended as a result of the survey. It was emphasized that the standards set were for the Miami River only and different objectives would be set up for each

individual river basin, depending on the results of surveys.

Cincinnati's Industrial Problems

"Approach By Municipalities" by A. B. Backherms, substituting for the late H. H. Kranz, City Engineer.

Mr. Backherms told of the laboratory studies made of the sewers of Cincinnati, wherein six types of industrial wastes were found which contribute 40% of all the suspended solids in the sewers. A sewer ordinance was drafted following the suggested model ordinance of the Federation.

Air Diffusion
J. J. Wirts
Supt.
Easterly Plt.
Cleveland, O.

Short School
W. D. Sheets
Asst. Engr.
State Hlth Dept.
Columbus, O.

Normal sewage was defined, and a normal suspended solids content of 300 ppm. and B.O.D. of 200 ppm. was established. Industrial wastes exceeding 2½ times the strength of the normal sewage on a daily average, or 5 times for a 15 minute period, would require pre-treatment at the industrial plant. Other limitations were also set up which would require pretreatment if exceeded and special charges fixed for wastes exceeding normal sewage strength.

"Aproach By Industries" by representatives of two industries.

V. E. Gex, Engineering Dept., Proctor and Gamble, Cincinnati, emphasized that his company wanted what was best for the community in which they lived, and wanted to be a member of good standing in the community. With that attitude in mind, every effort was being made to determine the scope of their industrial waste problem and to develop plans for the solution.

In a sewer survey, 27 separate sewer systems were found in the plant. Maps were made of the sewers, and all department processes were studied in an effort to reduce wastes at their source. This lead to change in some processes and the recovery of stock. Consulting engineers have been hired and pilot plants have been built for study of treatment methods.

S. M. Beckly, Chief Design Engineer, Emery Industries, Inc., speaking for E. A. Emmer, Dir. of Engr., said that since none of their sewers were connected to the Cincinnati sewer system, the treatment necessary for Emery Industries industrial wastes is controlled entirely by the standards set by the Ohio River Compact Commission. The first approach to the problem was the engaging of consulting engineers to list sources and measure flow of all sewage and waste, and to make analyses to determine their character.

Recommendations of the consultants were:

1. Rearrangement of sewer system
2. Partial treatment of portion of the waste and connection to the city sewers
3. Complete treatment of the remaining waste with disposal in Mill Creek

These recommendations are now being carried out.

INDUSTRIAL WASTE TREATMENT

Following the discussion of Cincinnati's industrial waste problems, the session split into two parts—one on industrial waste, the other on sewage treatment.

The industrial waste treatment session was presided over by H. S. Kline, Engineer Frigidaire Div., G.M.C., Dayton, Ohio.

Plating Wastes

"Treatment of Plating Wastes at Lockland Electric Auto-Lite Co." by Allan Reed, Chemist, Electric Auto-Lite Co., Lockland, Ohio.

After a study of the wastes involved it was decided to separate the sewers into four systems, one carrying chrome wastes, one alkali and cyanide wastes, one acid and oily wastes and the fourth electro-polish and bonderite wastes. An existing water plant which had been used for a lime-soda softening of well water was converted to a waste treatment plant, with the addition of reaction tanks.

It was found that certain of the wastes could be blended in the proper proportions neutralizing each other. Chromium wastes are reduced, cyanides oxidized, acids neutralized and other metals are precipitated by lime as the hydroxides. Sludge is disposed of in lagoons and removed later by dredging.

Between 1500 and 2000 gpm. flow is treated at a cost of 10c to 15c a thousand gallons. The plant is considering the use of the reclaimed water, after filtering, in its service water system for cooling.

Cyanide Wastes

"Experiences in General Motors Plants With Chlorination of Cyanide Wastes"; David Milne, Chemical Engineer, G.M.C., Detroit, Mich., Moderator.

Mr. Milne discussed cyanide wastes coming from plating and heat treating processes, and how his company was endeavoring to reduce the amount of wastes and in some cases eliminate them by changing processes. Copper is replacing cyanides in some instances.

The Pontiac Motor Division problems were described by E. G. Ray, Chief Chemist. Cyanide solutions at Pontiac, containing as high as 16,000 ppm. CN are carried to the plant in 1000 gallon tanks by truck. Caustic is

Toxic Wastes
Dr. Geo. E. Symons
Man. Editor
Wat. & Sew. Wks.
New York City

Ohio Compact
Ed. J. Cleary
Exec. Div.
Ohio Riv. Comp.
Cincinnati, O.

added and cyanides are destroyed by chlorinating for 48 hours. Effluent after thorough check is put into the sewer. Particular stress is put on the safe handling of cyanide and first aid.

The Detroit Motor Division was presented by P. W. Uhl, Chemist.

This paper dealt with the early experimental work on cyanides to determine the most economical and effective method of treatment. Proper training of personnel and precautions in methods of handling were stressed.

The Delco Remy Division treatment was given by C. F. Hauri, Plating Engineer, Anderson, Ind.

Mr. Hauri described Delco-Remy's unique cyanide treatment where chlorination of the cyanides is made the final stage of the plating process, the chlorination being done directly in the rinse tank of the plating machine. The pH is maintained between 8.5 and 10 with caustic soda and free chlorine is always maintained with a detention period of 2 hours.

The waste normally contains 200-400 ppm. cyanide and chemical cost has amounted to 50c per hour. The effluent is continually checked for chlorine as no cyanides will be present as long as free chlorine is maintained.

White Water Recovery

"Application of Oco Water System to Paper Mill White Water Recovery," by George C. Ehemann,

Plant Engineer, Ohio Boxboard Co., Rittman, Ohio.

The operation of the Oco water process for treatment of paper wastes, called white water, was explained by Mr. Ehemann. This process consists of alum coagulation and settling with the sludge, consisting of paper stock, returned to the plant for reuse. The settled effluent is filtered through plate and frame filters with the use of diatomaceous silica as a filter aid.

The effluent from this process is practically free from suspended solids and is reused giving a better water than most plants have for fresh water.

Beach Pollution
John S. Deles
Chemist
Easterly Sew. Plt.
Cleveland, O.

Sludge Digestion
T. C. Schaetzle
Sr. Assoc. Engr.
Sew. Treat. Plt.
Akron, O.

This gives a nearly completely closed system, only water losses due to evaporation, etc., having to be made up with fresh water. Since water is a major item in paper and boxboard manufacturing considerable savings are afforded.

A. J. Palladino, National Council for Stream Improvement of Pulp, Paper and Paperboard Industries, Kalamazoo, Mich., in discussing this paper, stressed the importance of the Oco System in aiding stream pollution abatement. The Oco System removes all of the suspended solids, and 40% of the B.O.D. Reduction of waste water volume is the primary objective of the system. Its use depends primarily on the stream requirements near the mill, the fresh water requirements and whether it will improve the quality of the paper. Mr. Palladino suggested that the low solids water should be separated at their origin.

"Evaluation of the Waste Disposal Problems of the White Paper Industries," by H. C. Koch, Chemist, Howard Paper Mills, Inc., Dayton, Ohio.

The preparation of white paper, a term used to include all paper of any color which is unprinted, was described by Mr. Koch. He explained the difficulties encountered in making fine paper as compared with paperboard manufacture. Alum and filter aids cannot be used, as they would result in a gritty paper. Color and quality are changed several times daily making it difficult to return solids from waste recovery processes for reuse. For a number of years the white paper industry has used more and more white water over again to save water and stock and Mr. Koch believes that no further gains can be made along this line.

The companion paper on paper waste disposal to have been given by Mr. R. H. Savage, Research Director, Mead Corp., Chillicothe, Ohio, was not presented due to Mr. Savage's absence.

SEWAGE TREATMENT

(The following session was reported by Walter E. Gerdel, Supt., Southerly Sewage Treatment Plant, Cleveland, Ohio.)

State Welfare Institutions

"Program of Improvement of Sewage Treatment Facilities at State Welfare Institutions," by E. F. Wittmer, San. Engr., Ohio Dept. of Pub. Welfare, Columbus, Ohio.

Mr. Wittmer discussed wastes handled, with the following being the principal types. Sanitary Sewage, Wastes from preparation of meals, Canning wastes, Slaughtering wastes, Laundry wastes, Milk processing wastes, Soap manufacturing wastes.

Disposal of Sewage is by the following methods:

1. Contact beds—generally plugged up and in need of rebuilding
2. Trickling filters which is the present principal design
3. Piping to municipal sewage treatment systems
4. Discharge into receiving bodies without any treatment. At the present time 29% of the total sewage flow is untreated

A contemplated Three Year Plan includes reducing untreated sewage flow to 11% of the total.

Sewage treatment facilities at the State Welfare Institutions have often been neglected and improperly operated in the past. There has been an aggressive educational program instituted by Mr. Wittmer in an endeavor to train the personnel in charge of these plants to a fuller understanding of the processes involved. Better operations are being experienced as the result of three short schooling periods.

Manufacturers Committee

F. D. Young
Johns-Manville
Cleveland, O.

J. A. Nicklis
Wallace & Tiernan
Columbus, O.

Saran Diffusion Tubes

"Air Diffusion With Saran Wrapped Tubes," by Mr. James Blodgett, Supt., Sew. Treat., Columbus, Ohio.

Mr. Blodgett reviewed the past aeration experiences at Columbus, which began in August, 1938. Five years of satisfactory operations resulted from the original design and installation of air diffusion plates grouted in pre-cast concrete air containers. Plate permeability was 40-45 with 1328 plates per tank.

Also Hosts

A. D. Caster
Sr. Engr.
Sewage Dept.
Cincinnati, O.

E. B. Evans
Supt.
Water Dept.
Cincinnati, O.

Air filtering equipment consisted of the conventional oil screen and dry paper type. One of the principal difficulties was the occurrence of "Blows" which was caused by the deterioration of grouting cement. First repairs consisted of the use of "Embecco" mortar, which eliminated for a short time the blows, but resulted in air pressure increasing from 7.3 to 8.5 psi. Higher pressure required additional power, and large and small blowers could not be operated in parallel.

One row of perforated pipe was installed in each tank during 1945, which improved operations somewhat. Continued difficulties and higher flows necessitated revision of aeration tanks or enlargement.

It was decided to modify the existing system to swing type diffusers to avoid the building of additional aeration tanks. Originally ceramic type tubes were specified, but when tests indicated the suitability of Saran wrapped tubes, a change was made. Installation took place May-Sept., 1948.

Benefits derived from this installation include:

Lower air pressure; more uniform distribution of air; ability to operate

the units maintaining good aerobic conditions at an increased capacity of 20% over the original designed rate of flow through the tanks.

From December 15, 1948 to April 15, 1949, the entire plant was shut down while new grit collectors were being cut into the intercepting sewer, and the sewer itself was cleaned of accumulated grit.

When the aeration units were placed back in service, it was found that the air pressure had increased 1.5 psi. Tubes were raised, air dried and brushed in place, and pressure was reduced .75 psi. Pressure, however, began to build up in a short time. It was concluded that sand left in the concrete containers in the aeration tanks was a factor in the clogging problem, and all sand was removed.

Tubes were removed and soaked for (12) hours in a 3% solution of sodium silicate, plus a non-ionic detergent, after which the tubes were passed through a high pressure water jet, which completely removed the softened and loosened material from between the cords. Some of the tubes stained with iron were soaked in a muratic acid solution for a short time.

Clean tubes were tested for a loss at 6 cfm. and were required to test within 1 inch of water pressure of that established for a new tube. Cleaning of all tubes resulted in air pressure dropping to 6.75 psi. while passing 5 cfm. per tube.

A gradual pressure build-up occurred over a 6 month period. In-place cleaning procedure is quite beneficial, and consists of raising units and cleaning off bacterial jelly coating by means of a high pressure water jet.

Every two or three years it is estimated that tubes should be removed from the tanks, soaked in the cleaning solution, jetted and reinstalled. Experience will determine the benefits realized from "jetting in-place" and complete cleaning by removal, soaking and jetting. At the present time it is estimated that raising and partially cleaning the tubes by jetting in-place costs about 2 cents per tube. Assuming that the tubes must be removed, soaked, jetted and replaced once every two years, and that the units must be raised and cleaned in-place twice a year, results in an estimated cost of 9 cents per tube to maintain in reasonably good condition.

DISCUSSION, by J. J. WIRTS:

Mr. Wirts drew some comparisons between the Columbus and Cleveland Easterly Plant experiences. The Easterly Plant is still using removable square air diffusers, and has been able to establish cleaning methods that have enabled the plant to adequately treat sewage flow in spite of general corrosion failure of the aluminum air diffuser manifolds.

The work of the Federation's Committee on Air Diffusion was mentioned.

Sludge Digestion

"SLUDGE DIGESTION TRENDS," by Mr. T. C. Schaetzle, Sr. Assoc. Engr., Sew. Treat. Plant, Akron, Ohio.

Mr. Schaetzle reviewed historically the digestion process and principles of design were reviewed along with present day operation methods and controls.

The problems of scum, poor supernatant and insufficient capacity were touched upon improvements, such as in the heating methods, have done much to eliminate some of the former problems.

It appeared to be the speaker's opinion, that the digestion process, even in the larger cities where there might be a tendency to eliminate it, it is more firmly established than ever before, and has demonstrated through the years its value.

Also Present from Cleveland

Left to Right—Harry E. Moseley, Geo. Horlacher, Frank Tolles, Russ Bowers, and E. S. Palocsay.—(The three in front from Havens & Emmerson Consultants—The two in rear Mfrs. Agents for Builders Iron Foundry.)—Poor cameraman almost cut Harry Moseley out of picture—sorry!

Short Schools

REPORT ON SHORT SCHOOL FOR WATER & SEWAGE TREATMENT PLANT OPERATORS by W. D. Sheets, Asst. Engr., Ohio Dept. Health, Columbus, Ohio.

Mr. Sheets reported on the results of the 1949 Short School held at Ohio State University, and outlined the tentative plans for the 1950 Short School at the same place.

He indicated that as the result of the past several years experience, that the visual and written type form of instruction is being emphasized in perference to the lecture type.

The final session consisted of four papers, but unfortunately it was impossible for us to report this session except for brief references to the papers.

"TOXIC WASTES IN SEWAGE" by George E. Symons, Managing Editor, *Water & Sewage Works*, New York City, presented a historical review of research and observations made in the past twelve years.

"THE OHIO RIVER VALLEY WATER SANITATION COMMISSION IN ACTION" by E. J. Cleary, Exec. Dir. and Chief Engr., Cincinnati, Ohio, reviewed the activities and successes of the Ohio Compact's first years of operation.

"CLEVELAND BEACH POLLUTION SURVEY IN 1949" by John S. Delos, Chemist, Easterly, Sewage Treatment Plant, Cleveland, Ohio. This paper presented the results obtained in the study of Cleveland beaches and commented on the effectiveness of sewage treatment in holding down beach pollution. The paper was discussed by H. W. STREETER, Consutant, Lake Erie Pollution Survey, Cincinnati, Ohio.

"THE SANITARY BIOLOGIST'S CONTRIBUTION TO WATER PURIFICATION" by John N. Wilson, In Charge, Stream Sanitation and Sewage Treatment Unit, Biology Section, Public Health Service, Cincinnati, Ohio. Mr. Wilson pointed out that unlike the chemist and bacteriologist who make inferential observations, the sanitary biologist actually makes direct observations of the organisms which are involved in sewage treatment processes. By watching these organisms it is possible to follow the course of treatment and to predict outcome as well as to stave off trouble when the wrong growths appear.

As examples, Mr. Wilson cited observations on the Hays Contact Aeration Process and on trouble with white sulfur bacteria in a trickling filter. Filter fly control can be followed by microscopic observations as can the progress of waste treatment in lagoons. Certainly biology is an important adjunct to the sciences that are being brought to bear on sewage and waste treatment.

Entertainment at the annual banquet included a very interesting commentary on this country's foreign policy. The speaker was WM. A. HESSLER, Feature Writer, Cincinnati Enquirer, Cincinnati, Ohio. Mr. Hessler is the author of the book, "Operation Survival," and is a radio commentator. His talk was well received.

SETTLING TANK DESIGN

A Resume of a Paper by F. Poepel Translated

by

C. E. KEEFER

Deputy Sewerage Engineer

BALTIMORE, MD.

PROFESSOR POEPEL of Stuttgart, Germany, has presented an interesting article in the August, 1949, issue of *Gesundheits Ingenieur* on the design of settling tanks for sewage and industrial wastes of similar characteristics. Prof. Poepel has derived several formulas for designing circular tanks which are here presented. The following is a résumé of his article.

Stokes law forms, in part, the basis of Prof. Poepel's conclusions. This law which relates to the settling velocity of finely divided suspended material in a liquid is

$$s = 0.0554 \frac{V-1}{n} d^2 \qquad (1)$$

where s = settling velocity in cm. per sec.
V = specific gravity of suspended material
l = specific gravity of the liquid
d = diameter of the suspended material, in cm.
n = viscosity of the liquid, in gram-sec. per square cm.

If the specific gravity of the suspended material and of the liquid remains unchanged, equation (1) can be simplified to

$$s = c.d^2 \qquad (2)$$

where c is a constant. Stokes law applies to solids with diameters between 0.05 and 0.35 mm. Particles with a specific gravity of 2.8 have the following settling velocity in water at 21°C.

$$s = 100.d^2 \text{ (small particles)} \qquad (3)$$
$$s = 12.5d^{0.75} \text{ (large particles)} \qquad (4)$$

Equation (3) applies where the flow is laminary and equation (4) where it is turbulent. Another general equation suggested for the settling velocity of mineral material in liquids is

$$s = c.d^x \qquad (5)$$

The value of x can be taken as 2 for laminary flow and 0.67 for turbulent flow. The value of c depends on the temperature of the liquid and the specific gravity of the material in suspension. For quartz sand and coal at a temperature of 10°C.

$$c = 7.15\ V^{2.5} \qquad (6)$$

and at a temperature of 20°C.

$$c = 12.V^{2.5} \qquad (7)$$

For sewage solids with a specific gravity of 1.2 c has an average value of 10.86. This value of c applies only for a temperature of 10°C. A more general equation for determining c is

$$c = 12.5.t^{0.5}.V^{2.5} \qquad (8)$$

where t is the temperature of the liquid.

In grit chambers the settling velocity of suspended solids with a diameter greater than 0.33 mm. can be determined in the laminary zone by the equation

$$s = 13.d^{0.7} \text{ (cm. per sec.)} \qquad (9)$$

For smaller solids settling in the laminary zone

$$s = 57.d^2 \text{ (cm. per sec.)} \qquad (10)$$

In this equation d is expressed in millimeters. Equations (9) and (10) serve to give the settling velocity of sand grains with a diameter ranging from 0.1 to 5.0 mm.

In settling tanks where the material to be removed is smaller in size and has a lower specific gravity than the material removed by grit chambers, the formula for the settling velocity in the laminar zone is—

$$s = 9.1d^2 \text{ (cm. per sec.)} \qquad (11)$$
$$s = 10.9d^2 \text{ (cm. per sec.)} \qquad (11a)$$

Equation (11) serves when the specific gravity of the suspended material is 1.1 and equation (11a) when it is 1.2. Table I gives the average settling velocity of suspended material with a diameter varying from 0.005 to 0.3 mm. and with a specific gravity of 1.1 and 1.2.

Table I

AVERAGE SETTLING VELOCITY OF SEWAGE SOLIDS WITH A SP. GRAV. OF 1.1 AND 1.2

Diameter of solids, mm.	Settling velocity, meters per hr. Specific Gravity of 1.1	Specific Gravity of 1.2
0.005	0.00821	0.0098
0.0075	0.0184	0.0221
0.010	0.0328	0.0392
0.025	0.205	0.245
0.050	0.821	0.981
0.060	1.139	1.411
0.070	1.610	1.921
0.08	2.10	2.51
0.09	2.99	3.18
0.10	3.28	3.92
0.15	7.61	8.82
0.20	13.54	15.69
0.25	21.12	24.50
0.30	30.41	35.28

Determination of Tank Surface Area

The surface area of a settling tank is generally determined for a settling velocity of the suspended solids of 1.5 to 2.5 meters per hr. As indicated by equations (11) and (11a) solids settling with these velocities have a diameter of

$$d = \sqrt{\frac{1.5}{328}} \text{ to } \sqrt{\frac{2.5}{328}}$$
$$= 0.0675 \text{ to } 0.0874 \text{ mm.}$$

The settling velocity s and the horizontal velocity v (Fig. 1) in a continuously operating settling tank act on the suspended material.

A rectangular settling tank with vertical sides is assumed to have a length of l, a width of b, a depth of h. The volume of water to be treated is q cu. meters per sec. Then v, the theoretical flowing-through velocity, is

$$v = \frac{q}{b.h} \qquad (12)$$

and

$$t = \frac{b.l.h}{q} = \frac{l}{v} \qquad (13)$$

where t is the theoretical detention period. To obtain good clarification a particle of water should leave the settling tank only when the suspended material originally contained therein has reach the *bottom* of the tank. The settling time S is derived from the formula

$$S = \frac{h}{s} \qquad (14)$$

As the flowing-through time and the settling time are one and the same

$$t = S = \frac{b.l.h}{q} = \frac{h}{s} = \frac{l}{v} \qquad (15)$$

and

$$q = b.l.s. \qquad (16)$$

As b.l is the surface area O, of a settling basin

$$q = O.s \qquad (17)$$

Equation (17) indicates that the efficiency of a settling tank depends only on the surface area and the settling velocity of the suspended solids. The depth of a settling tank, its traverse cross section, the longitudinal velocity and the detention period are of secondary importance. This last statement, however, overlooks the fact that a settling velocity s is attained only when the depth of a settling tank has some real value (see equation (14)).

Equation (15) can be used to determine the length, the width and the depth of any settling basin.

The relationship

$$\frac{l}{h} = \frac{v}{s} \qquad (18a)$$

is valid for circular tanks where the influent enters at the center and the

effluent discharges at the periphery. In such tanks the horizontal radial velocity decreases from the center to the periphery of the tank. The average radial velocity is half way between the center and the periphery. The area of the imaginary vertical surface at this point through which the flow passes is

$$F = \frac{\pi \cdot Dh}{2}$$

and this area can be equated to the rate of flow, q, divided by the flowing-through velocity. In the above-mentioned equation D is the diameter of the tank.

By using equation (17)

$$F = \frac{\pi \cdot Dh}{2} = \frac{q}{v} = \frac{O.s}{v} = \frac{\pi \cdot D^2}{4} \cdot \frac{s}{v}$$

$$\text{As } \frac{D}{2} = R \text{ (tank radius)}$$

$$\pi \cdot R \cdot h = \pi \cdot R^2 \cdot \frac{s}{v}$$

and

$$\frac{R}{h} = \frac{v}{s} \qquad (18b)$$

Equations (18a) and (18b) indicate that the ratio of the length to the depth of rectangular basins, or the radius to the depth of circular basins, equals the ratio of the horizontal velocity of the suspended material to the settling velocity. If the value of s in equation (5) is substituted in equations (18a) and (18b)

$$\frac{R}{h} = \frac{1}{h} = \frac{1}{c} \cdot \frac{v}{d^x} \qquad (19)$$

In this equation the ratio of the basin radius to the depth, or the ratio of the length to the depth, equals the ratio of the horizontal velocity of the suspended material to the diameter of the material.

Grit Chamber Dimensions

The dimensions of grit chambers should be based on a flowing-through velocity of 0.3 meter per sec. if grit with a diameter of 0.3 to 0.4 mm. is to be removed. To remove grit of a smaller size the flowing-through velocity should be reduced. Without committing a great error the velocity expressed in meters per second can be assumed equal to the diameter of the grit in millimeters when it settles in the laminary zone. By assuming v=d and referring to formula (10), formula (19) becomes

$$\frac{R}{h} = \frac{1}{h} = \frac{1}{0.57} \cdot \frac{d}{d^x} = \frac{1.75}{d} \qquad (20)$$

If the velocity in a grit chamber becomes less than v=d as for example v=0.75d, the constant in equation (20) then becomes 0.75 x 1.75 = 1.31. In the reverse situation where v is greater than d, the constant in equation (20) is correspondingly greater. Table 2 gives the relationship between the length and the depth of grit chambers when based on various flowing-through velocities.

Table 2

RELATIONSHIP BETWEEN THE LENGTH AND DEPTH OF GRIT CHAMBERS FOR VARIOUS SIZES OF GRIT TO BE REMOVED

Diameter, mm.	0.10	0.15	0.20	0.25	0.30	0.33
Velocity, m/hr.	0.10	0.15	0.20	0.25	0.30	0.33
Length/Depth	17.5	11.6	8.75	7.0	5.8	5.3

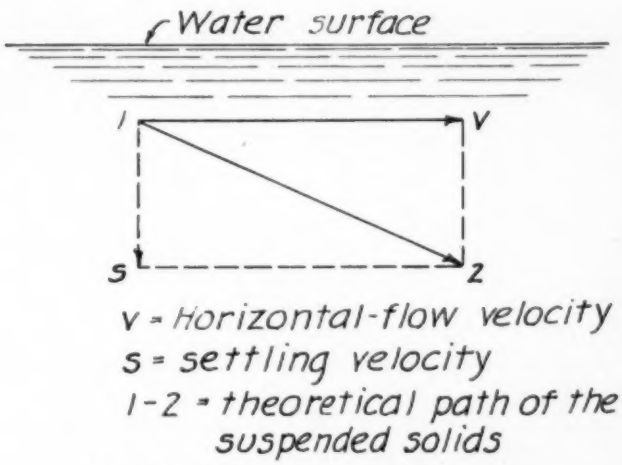

Fig. 1—External Influences Acting on Suspended Solids

Horizontal Movement Exerts but Little Influence

Experience indicates that the horizontal movement of water in a settling tank exerts no influence worth mentioning on the settling of suspended material. If x is given the value of 2 in equation (19), then

$$d = \sqrt{\frac{h}{lc}} \cdot \sqrt{v} \quad \text{mm}$$

With a constant ratio of water depth to basin length the diameter of the suspended solids varies with the one-half power of the velocity. If the velocity in a settling tank is doubled, only suspended solid 1.414 (equals $\sqrt{2}$ times larger will be removed.

It is not desirable that all settling tanks should be designed so that the ratio of length to working depth be a constant amount. This ratio should depend rather on the size of the suspended solids that are to be removed. As suspended solids of small diameter, because of their low settling velocity, must traverse a long horizontal distance before reaching the bottom of a tank, it is obvious that the ratio of the length of a tank (radius in the case of circular tanks) to its depth should be increased. Because of the lack of exhaustive experimental results, Prof. Pöpel for the sake of simplicity, suggests the following relationship for the ratio of the flowing-through velocity to the settling velocity:

$$\frac{v}{s} = \frac{c'}{d} \qquad (21)$$

Then the following relationship, based on equation 5, holds:

$$v = c' \cdot c \cdot d^{(x-1)} \qquad (22)$$

Suspended solids are precipitated only in the laminary zone in settling tanks. For this condition x=2. Equation (22) can then be written:

$$v = c' \cdot c \cdot d \qquad (23)$$

As equation (23) establishes the fact that the horizontal flowing-through velocity in a settling tank can be increased as the size of the suspended material to be removed increases, it may be considered as a confirmation of the correctness of the foregoing assumption. However, for practical purposes the relationship between the size of the suspended material and the horizontal flowing-through velocity ought to be established.

As a supplement to the foregoing relationship the formulas for determining the dimensions of settling tanks are developed as follows. Equation (17) can be written in the form

$$O = \frac{q}{s}$$

For a circular settling tank with a radius of R

$$\pi R^2 = \frac{q}{s}$$

$$\text{As } s = c \cdot d^2 \text{ (Eq. 2)}$$

$$\pi R^2 = \frac{q}{cd^2}$$

$$R = \sqrt{\frac{q}{\pi c d^2}} = \frac{1}{\sqrt{\pi c}} \cdot \frac{1}{d} \sqrt{q} \qquad (24)$$

The size of the settling basin de-

pends on the diameter of the suspended solids to be removed and the volume of liquid treated. This relationship appears logical, as the radius of the tank increases with the one-half power of the flow and must also be made greater, the smaller the suspended solids that are to be removed. Equations (18b) and (23) give

$$v = \frac{R}{h} \cdot s = c'.c.d$$

$$h = \frac{R}{v} \cdot s$$

Substituting the values for R, s and v given in equations (24) (2) and (23)

$$h = \frac{1}{\sqrt{\pi.c}} \cdot \frac{1}{d} \cdot \sqrt{q} \cdot \frac{1}{c'.c.d} \cdot c.d^2$$

$$= \frac{1}{\sqrt{\pi.c}} \cdot \frac{1}{c'} \cdot \sqrt{q} \qquad (25)$$

The depth of a settling basin is therefore dependent not on the size of the suspended material but only on the constants c and c' and the flow of sewage. As this relationship is ascertained from the actual observation that larger settling tanks ought to have a greater depth than those with smaller diameters, the conclusions drawn from the statement regarding the tank surface may be considered as correct in principle.

It is also desirable to determine the detention period t as a function of the size of the suspended solids and the volume of sewage being treated. The theoretical detention period results from the relationship of the tank depth to the settling velocity and of the radius to the horizontal flowing-through velocity.

$$t = \frac{h}{s} = \frac{R}{v}$$

(see equations 15 and 18b)

With the introduction of equations (23) and (24)

$$t = \frac{1}{\sqrt{\pi.C}} \cdot \frac{1}{d} \cdot \frac{1}{\sqrt{q} \cdot c'cd}$$

$$= \frac{1}{\sqrt{\pi}} \cdot \frac{1}{c^{1.5}} \cdot \frac{1}{c'} \cdot \frac{1}{d^2} \cdot \sqrt{q} \quad (26)$$

Therefore, the detention period must be greater, the larger the volume of water handled and the smaller the size of the suspended material removed. This equation is confirmed by practical experience. The constant c in the foregoing equation can be determined with the help of equations (6) and (8) for different specific gravities and temperatures. For suspended solids in sewage with a specific gravity of 1.1 $c = 0.091$ meters per sec. according to equation (11). The constant c depends upon the nature of the separated sludge. Relative to the determination of the value of c' for the preliminary clarification of sewage the dimensions of the preliminary settling tanks at the Paris-Acheres sewage-treatment plant are taken on account of their especially favorable clarifying ability. The basins, which were 35 meters in diameter and had a detention period of 1.5 hr., normally had a settling velocity of $s = 2.20$ meters per hr. With an average basin depth of h = s.t. = 2.20·1.50 = 3.30 meters a relationship of

$$\frac{R}{h} = \frac{17.5 \text{ meters}}{3.3 \text{ meters}} = 5.30$$

and an average flowing-through velocity of

$$v = \frac{R}{t} = \frac{17.5}{1.5} = 11.67$$

meters per hour. With this velocity suspended solids with a diameter of

$$d = \sqrt{\frac{2.20}{328}} = 0.082 \text{ mm.}$$

are removed in the settling basin. According to equation (21)

$$c' = \frac{d.v}{s} = 0.082 \cdot 5.30 = 0.435$$

For suspended solids with a specific gravity of 1.2 the value of c' would reduce to 0.397.

The determination of the constant c' for the separation of the biological sludge from secondary settling tanks is determined from the very favorable operating results with the secondary tank at the Amsterdam-West sewage-treatment works, in which the effluent from a high-rate trickling filter is clarified with a residue of 8 p.p.m. suspended solids. The circular secondary settling tanks, designed for a detention period of 1.5 hr. and with a diameter of 16.5 meters, has a settling velocity of 2.0 meters per hour. The average depth of the tank, therefore, amounts to h = 2.0 x 1.5 = 3.0 meters, the average flowing-through velocity

$$v = \frac{8.25 \text{ meters}}{1.5 \text{ hr.}} = 5.5$$

meters per hr. or 1.53 mm. per sec. and the ratio

$$\frac{R}{h} = \frac{8.25}{3.0} = 2.75$$

In the case of suspended solids with a specific gravity of 1.1 particles with an equivalent diameter of

$$d = \sqrt{\frac{2.0}{328}} = 0.078 \text{ mm.}$$

are retained in the tank. Therefore, in the case of final settling

$$c' = 2.75 \cdot 0.078 = 0.2142$$

A comparison of the two values of c' indicates that it is twice as great for primary settling tanks as for final settling tanks. But this relationship can be arrived at only if, with the same surface area, final settling tanks are made twice as deep as primary tanks. As practical experience fully establishes the theoretical derivations, the foregoing development of the equations can be employed to determine the dimensions of settling tanks, that will be economical and practical. While the value of c' appears to be ascertainable with sufficient accuracy for primary settling tanks, it would be desirable to determine it still more accurately for final settling tanks. The operating results of the final settling tanks for activated sludge at the Paris-Acheres sewage-treatment plant, which were made exactly as large and deep as the primary settling tanks, indicate that the depths of the primary and the final tanks do not need to be in the ratio of 1 to 2. However, smaller quantities of fine flocs, which would have settled in deep hopper bottom tanks, could not be retained in these flat final settling tanks with $c' = 0.435$. Very probably this minor disadvantage would have been avoided with final settling tanks of greater depth. Whether the better clarification in the deeper final tanks is traced back only to the blanket filtration effect of sludge flocs must be questioned with regard to the results obtained with the Amsterdam settling tank. However the foregoing operating experiences cause it to appear desirable to evaluate c' between 0.214 and 0.35 for final tanks. In consideration of the foregoing ascertained values of c and c' equations (24) to (26), inclusive, can be written in the accompanying simplified form:

	Primary Settling Tanks	Final Settling Tanks
Tank diameter (meters)	$D = \frac{3.74}{d} \cdot \sqrt{q}$	$D = \frac{3.74}{d} \cdot \sqrt{q}$
Tank depth, (meters)	$h = 4.30 \sqrt{q}$	$h = 5.50 \sqrt{q}$ to $h = 8.5 \sqrt{q}$
Detention period (hrs.)	$t = \frac{0.0131}{d^2} \cdot \sqrt{q}$	$t = \frac{0.0165}{d^2} \cdot \sqrt{q}$ to $t = \frac{0.0264}{d^2} \cdot \sqrt{q}$

The above-mentioned equations are valid only for circular tanks, in which the suspended material (d = 0.12 mm.) which settles within the laminary zone, is to be removed. Normally d is to be chosen between 0.07 and 0.08 mm. The value of q is expressed in cubic meters per sec., D

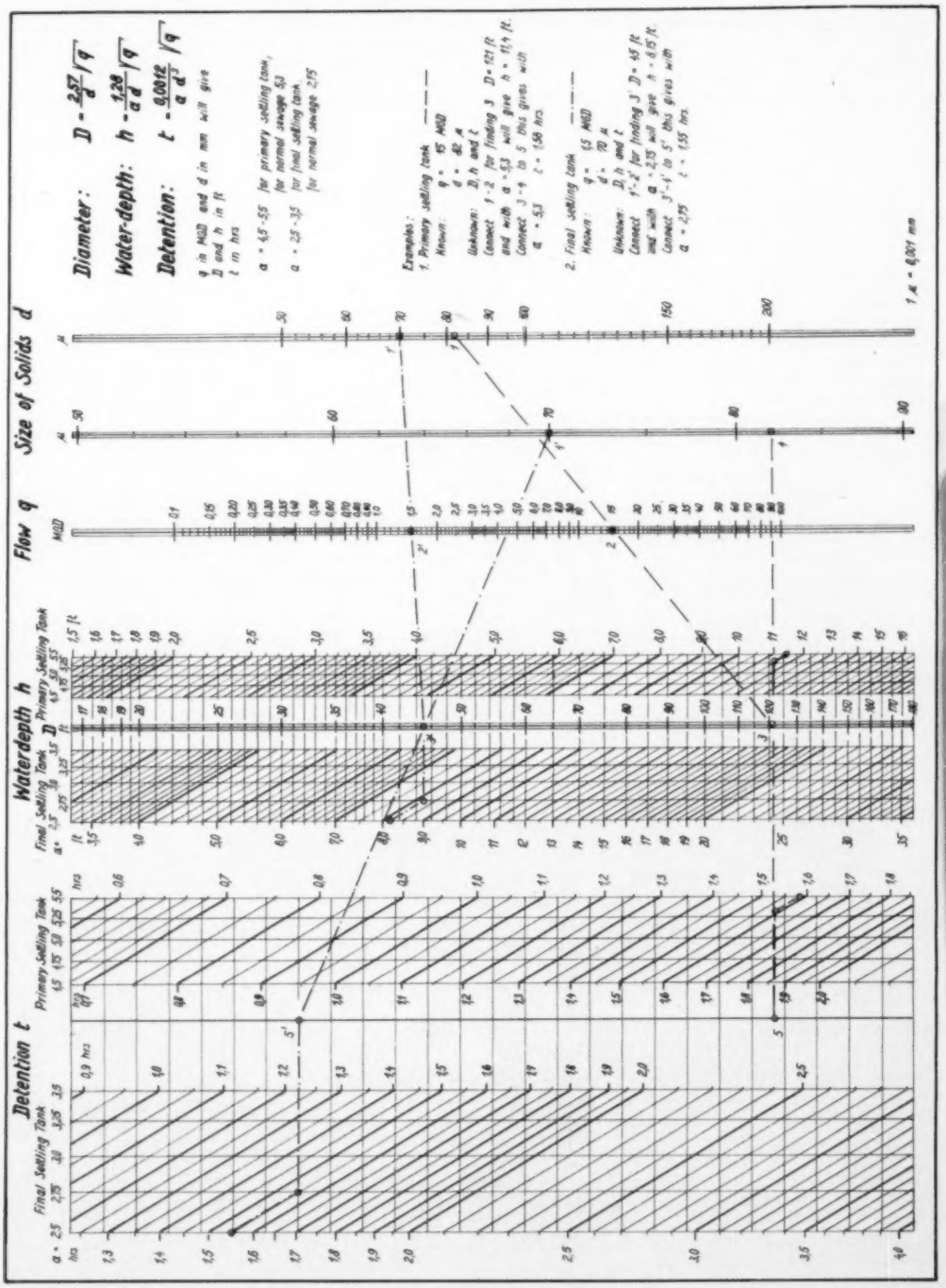
Diameter: D = 2.57/a √q
Water-depth: h = 1.28/a d √q
Detention: t = 9.0h²/a d³ √q
q in MGD and d in mm will give
D and h in ft
t in hrs
a = 4.5 - 5.5 for primary settling tank, for normal sewage 5.3
a = 2.5 - 3.5 for final settling tank, for normal sewage 2.75
Examples:
1. Primary settling tank
Known: q = 15 MGD
d = 40 μ
Unknown: D, h and t
Connect 1 - 2 for finding D. D = 121 ft
and with a = 5.3 will give h = 11.4 ft.
Connect 3 - 4 to 5 this gives with
a = 5.3 t = 1.56 hrs.
2. Final settling tank
Known: q = 15 MGD
d = 70 μ
Unknown: D, h and t
Connect 1'-2' for finding D. D = 45 ft
and with a = 2.75 will give h = 6.65 ft.
Connect 3'-4' to 5' this gives with
a = 2.75 t = 1.55 hrs.
1 μ = 0.001 mm
Size of Solids d
Flow q
MGD
Waterdepth h
Primary Settling Tank
Final Settling Tank
Detention t

Fig. 2—Nomograph for Determining Proper Diameters, Water Depths and Detention Periods for Circular Settling Tanks With Radial Flow

in meters and t in hours. The relationships derived for the settling velocity of suspended solids with a greater specific gravity than one are also valid for the ascending movement of suspended solids with a specific gravity less than one. The question relates to the separation (floatation) of grease and light oil which, on account of the continuous retardation of the flowing-through velocity and the calming of the water surface, collect on the surface. The required surface for the separation of grease can be calculated in like manner as for the separation of settleable solids. In this case the ascending velocity of the lighter solids must be used instead of the settling velocity. According to the investigations of Zunker the ascending velocity of linseed oil amounts to 0.004 meters per sec. Therefore, it is just as great as the settling velocity of sand with a diameter of 0.08 mm. or as that of the suspended solids in sewage (specific gravity of 1.2) with a diameter of 0.25 mm.

The ascending velocity of grease and oil varies over a wide range, which is determined by its specific gravity and by its dispersion in the sewage or trade waste. In spite of the emulsified state of the grease, the great surface tension can be decreased so that the scum separates more quickly and easily in settling tanks. According to experiences in America the separation of grease is materially increased when 2 p.p.m. of chlorine is added to the sewage in addition to air under pressure. The grease, which is released from its emulsified form by means of chloro-aeration, is conveyed with the settling solids to settling tanks, where it separates on the large surface of the tanks, which are equipped with skimming mechanisms. In this way the customary skimming tank is simplified to an aeration tank with a short detention period.

ADDENDA

by
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The use of the equations for calculating the radius, water depth and detention period of sewage in circular settling tanks with radial flow is simplified by the nomograph shown as Figure 2. Actually this nomograph cannot be used to solve equations (25) and (26) in Mr. Keefer's resume. These are based on the assumption that the horizontal water velocity is equal to the product of two constants c' and c and the diameter d of the solids to be removed (Eq. 23). It however permits one to choose different values for the ratio of the tank diameter to the water depth and of the horizontal water velocity to the settling velocity of the solids. When choosing this ratio it should be kept in mind that it has a low value when small solids with a flocky character have to be removed. It can be increased when larger solids with a grainy character have to be settled in the tank.

Tank diameter. When using equation (24) with $c = 0.091$ the equation for the tank diameter is

$$D = \frac{2}{\sqrt{\pi}\,c}\,\frac{1}{d}\,\sqrt{q} = \frac{3.74}{d}\,\sqrt{q} \qquad (27)$$

Water depth. If a is the ratio for

$$\frac{R}{h} = \frac{v}{s}$$

equation (25) will give

$$h = \frac{1}{\sqrt{\pi}c}\cdot\frac{1}{a.d}\,\sqrt{q} = \frac{1.87}{a.d}\cdot\sqrt{q} \qquad (28)$$

Detention period. Equation (26) will give with

$$a = \frac{R}{h} = \frac{v}{s}$$

$$t = \frac{1}{a}\,\frac{1}{c^{1.5}}\,\frac{1}{\sqrt{\pi}}\,\frac{1}{d^2}\,\sqrt{q} = \frac{0.0057}{a.d^2}\cdot\sqrt{q} \qquad (29)$$

The use of the nomograph is explained by two examples:

The same principle can also be applied for deriving the equations for the dimensions of rectangular tanks l meters long and b meters wide with a surface area $O = b.l$

If b is expressed as a function of l in the form of

$$b = \frac{l}{n},$$

it follows from equations (2) and (17) that the length of rectangular settling tanks is

$$l = \sqrt{\frac{n}{c}}\cdot\frac{1}{d}\,\sqrt{q} \qquad (30)$$

With the introduction of $\frac{1}{b} = a$ in equation (18b) it follows that

$$v = \frac{1}{h}\cdot s = a\cdot c\,d^2\cdot$$

By introducing the value for l in equation (30) it follows that the water depth

$$h = \sqrt{\frac{n}{c}}\cdot\frac{1}{ad}\cdot\sqrt{q} \qquad (31)$$

By combining equations 15, 18b, 30 and 31 the detention period in rectangular tanks is given by the formula

$$t = \frac{1}{a}\cdot\frac{1}{c^{1.5}}\,\sqrt{n}\,\frac{1}{d^2}\cdot\sqrt{q} \qquad (32)$$

The comparison of the corresponding equations for the dimensions of circular and rectangular settling tanks shows that they have in principle exactly the same form. Therefore rectangular tanks will have the same clarification efficiency as circular ones if

$$\sqrt{n} = \frac{1}{\sqrt{\pi}} \text{ or } n = \frac{1}{\pi} = 0.318$$

Normally the value of n will be much greater.

This permits the theoretical conclusion, which has been confirmed by practical experience, that radial-flow circular tanks will have a greater clarification effect than rectangular tanks with the same surface area.

NEW YORK LETS $32,500,000 IN SEWAGE DISPOSAL CONTRACTS

Record Year in City's Five Year Program Involving $100,000,000 for Sewage

New York City's Dept. of Public Works now has in operation 13 sewage treatment plants and by the end of 1953 will have 6 more new plants in operation if the program develops according to schedule.

During the past year, says the annual report of New York's Commissioner of Public Works, F. H. Zurmuhlen—

An unprecedented amount ($32,500,000) of contracts awarded for construction of sewage disposal facilities and the completion of more than $8,000,000 construction work on these plants, is the highest on record.

The City's $100,000,000 5-year sewage disposal program, initiated by the Mayor in 1948, was substantially advanced to keep the City abreast of an ambitious schedule to rid all of its Class "A" waters of pollution by 1953.

Elimination of pollution in all waters surrounding New York City will be accomplished in a supplementary sewage disposal program to be completed by the end of 1958.

The greatest gains in the city's history of sewage disposal were made in 1949, and the accelerated speed with which sewage treatment works are being carried forward is best illustrated by the fact that between January 1, 1946 and December 31, 1949, total contracts awarded amounted to $41,300,000 and total construction completed was $11,744,000.

At this rate the City will have, by the end of 1953, six new sewage treatment plants, in addition to the 13 now in operation. The new ones will serve the Hunts Point area of The Bronx; the Gravesend, Fort Hamilton and Bay Ridge areas of Brooklyn; the Rockaway peninsula in Queens; and part of the Borough of Richmond. The Bowery Bay Sewage Treatment Plant also will be expanded to triple its present capacity and serve the Long Island City area in Queens.

SEWAGE TREATMENT PLANT EQUIPMENT

SLUDGE DIGESTION TANKS

*The Fourth Article of a Series**

by

FRANK L. FLOOD
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CONSIDERABLE mechanical equipment is usually involved in modern separate sludge digestion systems. Among the more important items requiring consideration are, floating covers, gasometer-type covers, fixed steel covers, heating systems, sludge removal, recirculation systems, gas collection, supernatant withdrawal and scum control.

The Author

Floating Covers

John R. Downs, Superintendent of the Joint Meeting Sewage Treatment Plant at Plainfield, N.J., is credited with the design of the first floating cover for a separate sludge digestion tank in the United States. The simple wooden cover designed by him has been developed by the Pacific Flush Tank Co. into a modern mechanism built of steel with guides, controls, supernatant selectors, pressure and vacuum relief valves, gas domes, manholes, sampling hatches, level indicators and other appurtenances. The original floating cover patents have expired and other companies now compete for the floating cover business. This relatively new competitive condition places a responsibility on the engineer to draw up plans and specifications which will assure truly competitive bidding and that his client will receive equipment which will meet the requirements for service and long life.

The engineer is also responsible for weighing the costs and comparative advantages and disadvantages of the floating covers with gasometer and fixed covers of various types and forms.

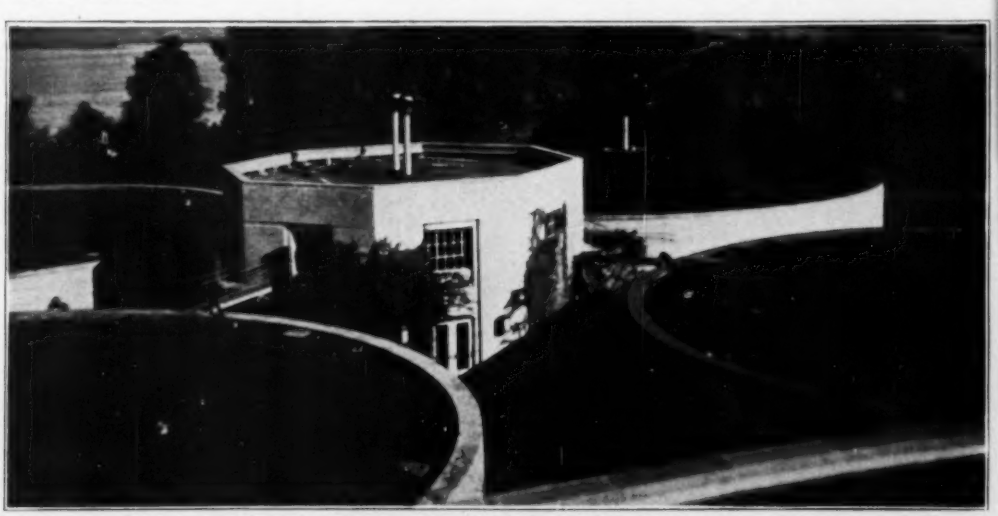
There has been some experience with tilting of covers with resultant jamming and some damage to the equipment. Guides and extended rollers have been used in some instances for the purpose of controlling tilting.

Under certain conditions floating covers have been known to freeze in a fixed position for several weeks at a time. Heat has been applied to the annular ring between the cover and the tank walls to correct this condition.

The natural weight of the floating cover may not provide the desired gas pressure. In some instances weight has been added to the cover to increase the gas pressure.

The floating covers ride on the liquid surface or scum. Provision should be made to prevent the rapid loss of heat through the cover. This can normally be accomplished by covering the roof over the ceiling

*Other articles in this series appeared in May, June and August.



Separate Sludge Digesters with P.F.T. Floating Covers—Buffalo, N.Y.

(Four 90 ft. dia. tanks with sludge control house center containing P.F.T. heat exchangers, gas and sludge control devices and recirculation pumps.)

Sludge Digesters at Hagerstown, Md.
(Note motor on top center of left tank for powering mixer. Also note pressure-vacuum relief valves.)

plate with corkboard, foam glass or other insulating material. The insulating material should be protected by roofing. In some instances heat has been applied to the air space between the ceiling plate and roof in order to heat the top of the digestion tank[1].

Gasometer Type Covers

The gasometer type of cover has been extensively used by the Dorr Co. in the secondary tank of its so-called Mult-digest system. It is also quite commonly used where engineers desire a relatively small volume of gas storage and find it convenient to provide this at a digestion tank, or a sludge storage tank, rather than in a separate holder. The depth of gas storage under the gasometer cover is usually on the order of 2 to 6 ft. or more. The Dorr Co. has used a center column and Pacific Flush Tank Co. has used a spiral guide, to prevent tilting of the gasometer cover.

Fixed Steel Cover

The Dorr Co. has commonly used a fixed-steel cover on the roofs of primary digestion tanks in its Mult-digest system. Competitive bids between fixed steel domes and fixed concrete roofs for the large digestion tanks at the Los Angeles Hyperion Plant in 1948, favored concrete dome roofs.

Heating Systems

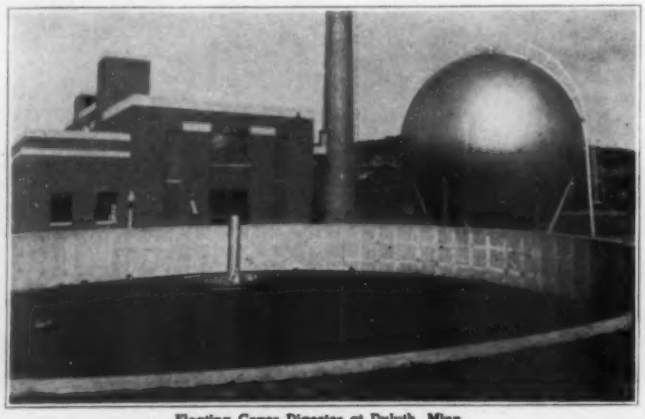
For about 20 years prior to 1947, the majority of digestion tanks were heated by means of hot water circulated in coils within the tanks. These installations if designed with ample area and operated at relatively low temperature of hot water, if constructed of suitable materials and joints, if adequately supported and if not seriously affected by electrolytic action, have given very satisfactory service. There are enough "ifs" in the design, construction, and operation of those heating coils so that failures have been recorded.

Recently the tendency has been away from the use of hot water coils inside the tanks towards enclosed heat exchangers outside the tanks. This has been promoted in part by the sales efforts of the manufacturers, particularly at first by the Pacific Flush Tank Co. and more recently by Walker Process Equipment Co., the Dorr Co., and others. The separate heat exchangers are usually designed to heat the raw sludge being admitted to the tank or liquor circulated from the tank. In the latter case, the heated recirculated liquor may be added to the raw sludge for rapid conditioning.

Direct contact combustion heaters have been installed in the digestion tanks at Baltimore[2] and at Philadelphia[3] and the control of temperature in digestion tanks with live steam has been described by Rawn[4].

The digestion tanks at the Los Angeles Hyperion plant are heated by means of steam admitted into the flow tube below the impellers of Dorr mixers. The steam is reclaimed from the vapor phase system at the dual fuel gas diesel engines. Where direct steam heating is used, the water should be treated as required to prevent operating difficulties at the steam boilers.

Infilco, Inc. has developed a so-called "Verti-Flo" impeller for installation in the scum zone of diges-



Floating Cover Digester at Duluth, Minn.
(Note spherical gas holder in rear)

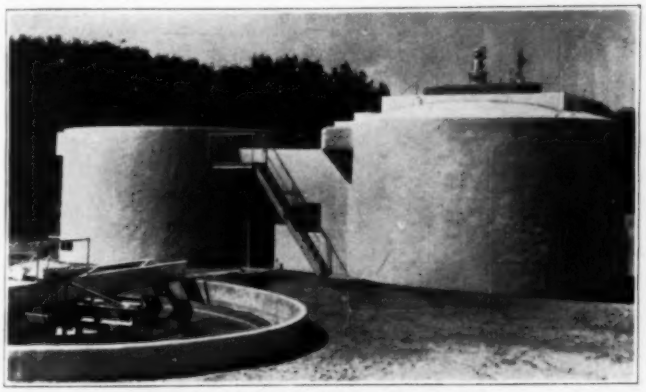
tion tanks. Heating coils are installed at the mixer in a vertical bank which can be withdrawn through a manhole in the roof.

Scum Control

Possibly the greatest single difficulty experienced with the operation of sludge digestion tanks has been in accumulation of masses of relatively inert scum which renders ineffective a substantial proportion of the tank capacity, clog supernatant and overflow pipes, and create numerous operating problems. It appears that if the scum is kept well mixed with warm tank liquors, the scum-forming materials will continue to digest and for the most part settle to the bottom with the sludge. If well lubricated by tank liquors, excess accumulations of floating materials can be withdrawn through piping connections in the upper portion of the tank.

Several schemes have been developed designed to meet the scum problem. A few will be briefly described. In tanks equipped with floating covers, the Pacific Flush Tank Co. recommends the installation of a circulation system designed to produce a flow and mixing action at the center of the tank in the gas dome. In theory, scum accumulating under the floating cover and outside the limits of the gas dome will flow into the center and receive treatment.

The Dorr Co. recommends the installation of propeller mixers installed in the scum zone below the roofs of fixed-roof tanks. These are designed to mix the scum with the underlying tank liquor. Favorable results have been reported with this equipment at Stamford, Conn. Units of this type have been installed in the digestion tanks at the Hyperion



Dorr Co. Multidigestion System at Carmel, Calif.

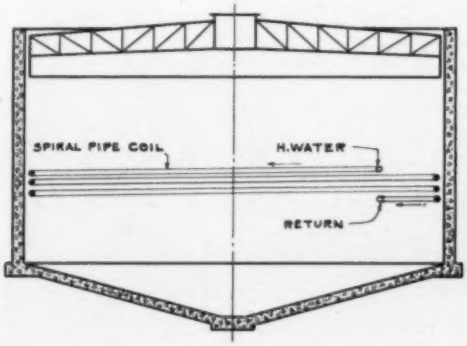
Plant in Los Angeles. Where particular types of industrial wastes conducive to the formation of very heavy scum masses are to be encountered, this company has recommended mechanical mixers with slowly revolving stirring arms passing between fixed teeth suspended from the roof. Similar equipment is supplied by Hardinge Co., Yeomans Bros. Co., and Infilco, Inc.

For circular fixed roof tanks, the author[6] has recommended the circulation of liquor at relatively high rates, the liquor being drawn from beneath the scum zone and discharged just above the normal liquid or scum level. Four discharge nozzles are provided located at about quarter points in plan and inclined at about 45°, directed so as to cause a circulatory motion in the scum and to bring scum not directly under the nozzles into the active turbulent mixing areas. An installation of this type on a primary digestion tank, 50 ft. in diameter, at Bristol, Conn., has proven very effective in quickly eliminating a mass of heavy scum which formed during the early weeks of operation before the circulating liquor was discharged through the scum nozzles above the liquor level. After this heavy scum was eliminated, it has been found practical to restrict scum accumulation to a relatively thin soft layer by operating the recirculation system a few hours each day.

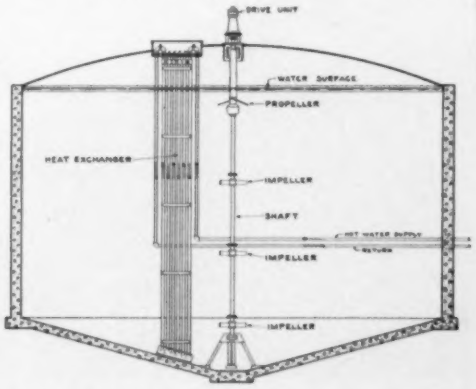
For square or rectangular tanks, the Link-Belt Co. makes a scum breaker which consists of a number of paddles attached to a pair of endless chains moving through the scum at a speed of about 1 fpm. The return flight is through the mid depth of the tank.

Sludge Removal Mechanisms

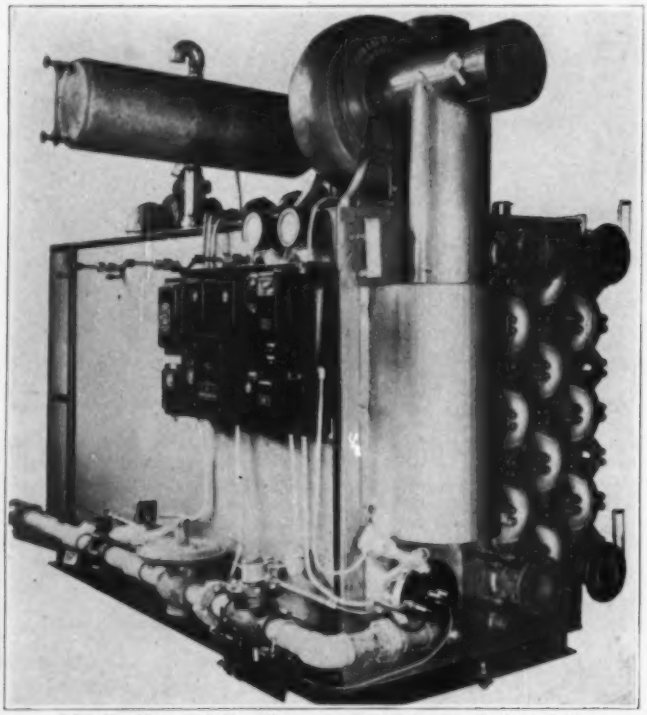
In the earlier designs, digestion tanks were equipped with sludge removal mechanisms similar to those provided for circular and rectangular sedimentation tanks. The operation and maintenance of this equipment proved to be difficult and expensive.



Digestion Tank with Spiral Pipe Internal Heating Coil (After Wittwer)



Digestion Tank with Vertical Bank Type of Heat Exchanger (After Wittwer)



P.F.T. Hot Water Bath Type Heater and Heat Exchanger—Stockton, Calif.
(Twin sludge inlet and outlet connections in front and connections for circulating engine cooling water in rear.)

Recently circular tanks have been provided with inverted conical bottoms to promote the withdrawal of sludge without the aid of mechanical equipment. Relatively few rectangular digestion tanks have been built or proposed during the recent years.

Supernatant Withdrawal

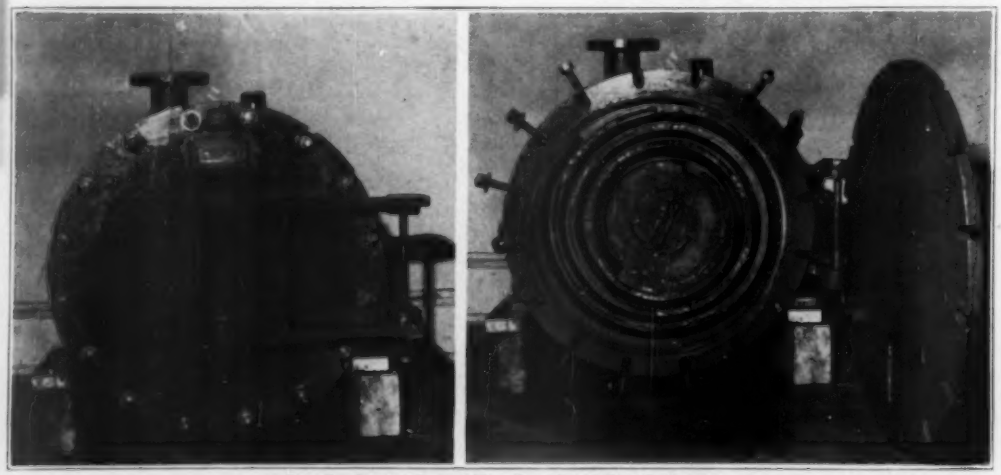
Normally as raw sludge digests there is a separation of relatively dilute liquor from the concentrated sludge or scum. This dilute liquor usually collects over the bottom sludge and under the scum layer. In the majority of plants multiple pipe connections are made to the tanks in the zone where dilute liquor is most apt to collect and provision is made for supernatant withdrawal by selection after sampling to determine where the clearest liquor may be obtained.

The new tanks at the Hyperion plant in Los Angeles are equipped with a swivelled supernatant withdrawal pipe operated by means of a cable and winch rigging. The cable passes through the tank roof by means of a Varec fitting designed for a 12-in. water seal.

The Pacific Flush Tank Co. advocates the use of its "Supernatant Selector." This consists of a slotted tubular device mounted vertically at the central portion of the digester and extending throughout the portion of the depth from which supernatant is normally withdrawn. The tube is made with slots that are intended to be sufficiently narrow to hold back liquid containing large amounts of suspended solids and to pass the clearer liquid for withdrawal from the tank. Provision is recommended for backflushing as needed to clear the slots.

Gas Domes

In some early designs of digestion tanks, gas was withdrawn from a low, small dome, not much more than a manhole cover, in the roof not far above the sludge level. Experience soon indicated the need for larger and taller domes as under



Dorr Co. Counter Current Flow Type Spiral Heat Exchanger
(With front door closed) *(With front door open)*

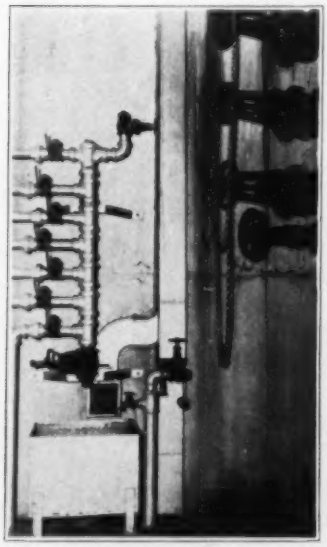
high rates of gas production there was at times sufficient disturbance of the liquid surface under the dome to carry moisture and particles of sludge and scum into the gas system. With domed roofs, the clearance between the liquid level and dome at the center of the tank is usually sufficient to minimize the requirements for a separate gas dome. For flat concrete roofs and floating covers, more elaborate gas domes should be provided.

Pressure and Vacuum Relief

Sludge digestion tanks, regardless of the type of roof, require provision for pressure and vacuum relief. Undue pressure within a tank may be created by sludge inlet pumps operating at a time when all outlets to the tank are closed or clogged. A vacuum may be created by the withdrawal of sludge at a greater rate than sludge is being admitted or sludge is being introduced.

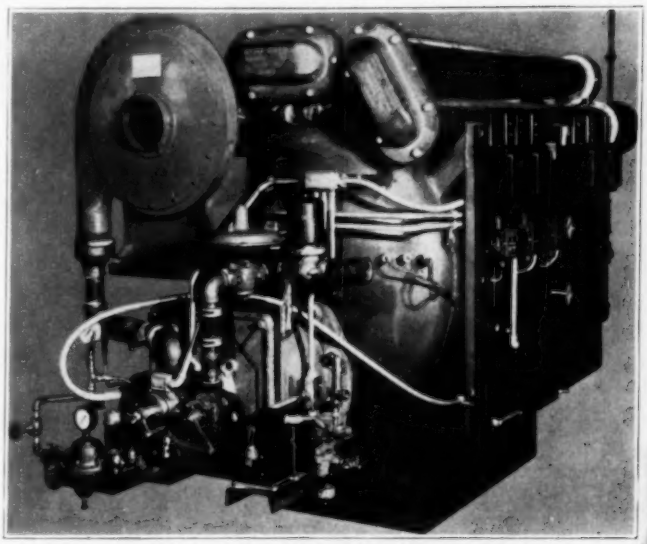
Early designs of pressure and vacuum relief devices which relied on a "leg" of oil or water proved somewhat troublesome because of evaporation, freezing, "blowouts" or other difficulties.

Vapor Recovery Corp., Pacific Flush Tank Co. and others have developed valves which permit gas to escape from the tank if the pressure rises above a predetermined level or permits air to enter the tank if there is a tendency for vacuum to form.



Sampling and Supernatant Zone Finding Lines

(On right—supernatant draw-off lines and valves)



East Lansing, Mich.—Walker Process Equip. Co. Heat Exchanger

These valves are equipped with flame arresters to prevent a flame from flashing back into the tank when the vacuum release feature is operating.

Careful attention must be given to the design and operation of these valves. In one type of valve, some trouble has been experienced due to freezing of condensation in such a manner as to render the valve inoperative during severely cold weather. In another type of valve, the protection afforded depends upon the replacement of oil which may evaporate or be accidentally displaced.

Normally the floating cover is not subject to vacuum. However, in the event sludge is withdrawn while the cover is resting on the landing ledge, a sufficient vacuum can be created, unless a vacuum relief valve is provided, to cause serious structural damage to the cover.

General Comment

Particular attention should be given to the protection of structural steel members, cables, and other metal parts immersed in sludge digestion tanks from the corrosive effects of sewage sludge and possibly also from galvanic or electrolytic action. The difficulties encountered in the latter respect in a sludge digestion tank at the Terminal Island plant in Los Angeles have been described by Parkes[6].

Oil and grease lubricated bearings should not be used inside of digestion tanks. It is preferable to support rotating equipment from the structural roof using thrust bearings.

Piping should be designed of generous size. Maximum rates of gas production may be several times the average rate and should be provided for. Undersized sludge inlet and withdrawal piping has led to serious difficulties in a number of instances.

For the most part, the equipment installed within digestion tanks prior to World War II has not proven very satisfactory. The work of cleaning out a digestion tank and the making of repairs on mechanical equipment installed therein is laborious and distasteful to the operators. In many small plants with only one or two tanks, the withdrawal of one tank from operation to make repairs may necessitate by-passing a portion, if not all of the sewage flow, during the repair period.

It is hoped that the newer developments will prove longer lasting and more effective than some of the earlier.

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MECHANICAL DEWATERING OF PAPERMILL SLUDGES

by
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Development Engineer*
NEW YORK CITY

THE concentration of pulp and paper mill waste sludges by mechanical dewatering means has received considerable attention because of the immediate and pressing problem represented in disposal of the sludge. Varying degrees of testing have been reported for deinking[1], semi-chemical[2], and strawboard[3] mills.

This paper reports the results of extensive field testing at a variety of mills. These mills included two integrated pulp and paper mills, a bond mill, a tissue mill, and a fibre mill.

The dewatering techniques investigated included rotary vacuum filtration, pressure filtration, and two stage vacuum filtration.

Equipment

The rotary vacuum test leaf results reported below for the integrated mill were determined with a 0.1 sq. ft. test leaf covered with a 100 mesh stainless steel filter medium. The results are reported on the basis of a 43.5 per cent vat submergence at ½ rpm. drum speed and 18-in. vacuum. Where results obtained with a portable rotary vacuum filter are given, they were determined with a one foot by one foot test unit. This unit was covered with a 60 by 40 mesh stainless steel filter medium and operated at 25-in. vacuum at 4/9 rpm. drum speed with a drum submergence of 25 percent.

For the pressure filter tests, a 7 by 7-in. plate and frame unit was used. Sludge was fed to the filter from a tank under 85 to 90 psi. pressure.

The two stage vacuum filtration tests were accomplished with a 1/5 sq. ft. tube leaf for the first stage, and a conventional 1/6 sq. ft. leaf test (simulating 1/5 rpm. drum speed) for the second stage.

This latter two stage continuous vacuum filtration is accomplished by preceding a conventional rotary vacuum filter with a continuous vacuum tube thickener. Since the thickener is relatively new equipment, a brief description will be offered.

A series of tubes is immersed in the sludge feed. Vacuum is applied to these tubes until a cake is formed on the exterior of the tube. Vacuum is then cut off and a small portion of the filtrate is returned back through the filter medium, the tubes now oscillating. The cake is sloughed off, falling through the feed to a hopper bottom containing an agitator from whence it is drawn off and sent to the rotary filter. The manufacturers claim for this equipment new developments, especially in the technique for removal of the cake from the filter medium.

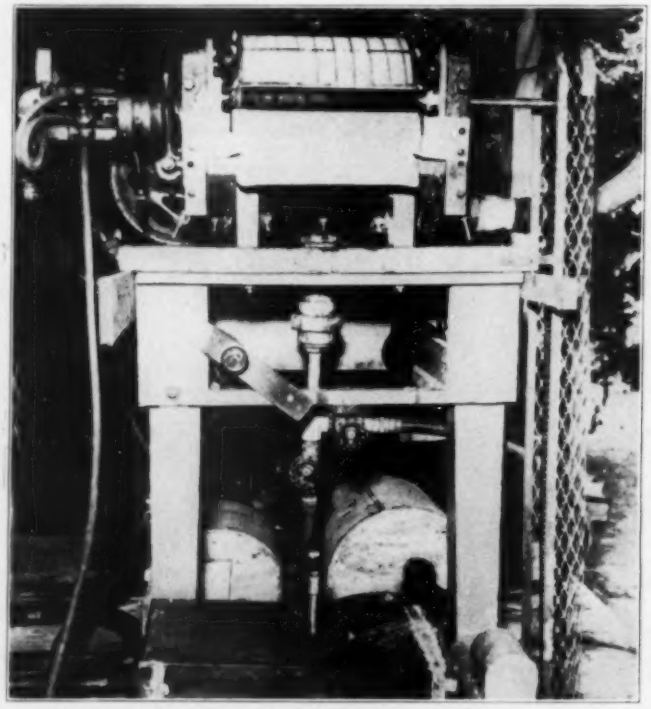
Sludge Characteristics

The two integrated mills investigated were a soda mill and a sulfite & soda mill. Both make paper from their respective pulps and old paper stock.

At the sulfite & soda pulp and paper mill three types of sludges were formed. The first was obtained by plain sedimentation of a mixed waste which included rejected white water, pulp tail washings, pulp bleaching wastes, cleanup wastes, and floor washings. This sludge had a consistency of about 4 per cent and a solids ash content of 25 per cent.

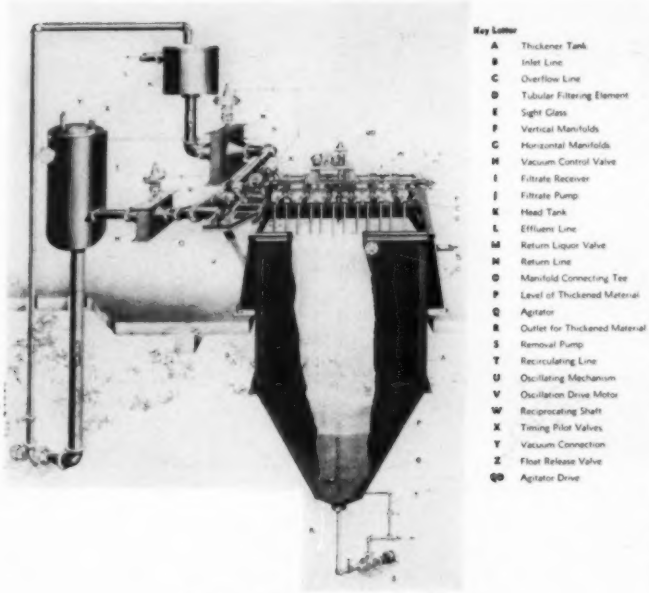
The second sludge was obtained by plain sedimentation of this mixed waste in combination with deinking waste in a ratio of nine to one. This sludge had a consistency of 4.22 per cent and a solids ash content of 43 per cent. The third sludge was that produced by alum coagulation and settling of the mixed waste plus the deinking waste. In this case the sludge consistency was 2.0 per cent.

Sludge from the soda pulp and



Portable Oliver Vacuum Filter Test Unit Used in Experiments Described Herein

*National Council for Stream Improvement —of the Pulp, Paper, and Paperboard Industries.



EDCO Continuous Vacuum Thickener

paper mill was produced by plain sedimentation of a mixed waste which in this case included deinking waste, rejected white water, pulp bleaching waste, cleanup waste, floor washing and cooling water. As in the case of the soda and sulfite mill, this sludge was collected in a 10,000 gallon pilot settling unit. The average consistency of sludge collected in the pilot plant during twenty-six eight hour runs was 3.4 per cent. On an average this sludge compacted to 4.4 per cent after four hours additional settling. Since mechanical sludge scrapers were not provided, this latter concentration should be closer to that which may be expected from a full scale treatment plant. This sludge averaged 42 per cent in solids ash content.

Sludge from the tissue mill was collected by means of a 500 gallon pilot settling unit, with alum added to the feed. The resulting sludge had a consistency of just under 1.0 per cent consistency and was high in volatile content.

At the fibre mill sludge was collected by treating the riffler and beater wash water with alum and settling the same in a 12,000 gallon tank. A sludge of from 1.0 to 1.5 per cent consistency was produced with varying volatile content.

Facilities were not available at the bond mill for representative waste sludge collection, and therefore concentrate from a flotation save-all was utilized. This concentrate was deemed to have characteristics which would indicate the type of dewatering which would be necessary for the waste sludge. In this respect it is composed of over 50 per cent clay filler. The only chemical added to the save-all feed is rosin, sufficient alum being present in the white water to form a floc. This concentrate was tested at its usual concentration, about 1 per cent.

However, this concentrate will compact upon several hours settling to concentration of 2 to 3 per cent. In this respect it differs from the fibre and tissue mill sludges which tend to resist further compaction by settling.

Table 1

LEAF TESTS ON WASTE SLUDGE FROM A SULFITE & SODA PULP AND PAPER MILL

Type of Waste	Treatment	Number of Tests	Filter Loading Dry lb./sq. ft./hr.	Wet Cake Thickness (in.)	Cake Moisture %
Mixed Waste	Plain Sedimentation	7	14.4	¼	81
Mixed Waste & Deinking	Plain Sedimentation	12	7.6	⅛	76
Mixed Waste & Deinking	Alum Coagulation	5	1.1	1/32	78

Procedure

In obtaining the various loadings, the following procedure was followed:

The three sludges from the sulfite & soda pulp and paper mills were tested with a leaf simulating rotary vacuum filtration.

Sludge from the soda pulp and paper mill was tested with a one-foot by one-foot portable rotary vacuum filter.

Some additional investigations were made to determine the effect of addition of black ash or granular carbon. This black ash had demonstrated by chance its ability to increase filter loadings materially. The effect of addition of lime was also studied.

At the bond, tissue, and fibre mills, the inability to dewater by straight rotary vacuum filtration was established because of the thin, undischargeable cake. As a means of investigating suitable methods for dewatering these sludges, the following tests were performed.

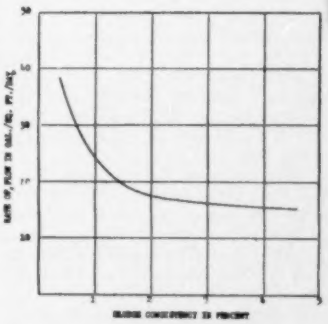
At the tissue mill, the sludge was tested at a variety of concentrations with a pressure filter. The sludge was also tested with leaf tests simulating two stage vacuum filtration.

The save-all concentrate from the bond mill was subjected to pressure filter tests. This concentrate was also subjected to testing with a portable rotary vacuum filter which proved unsuccessful because a dischargeable cake could not be formed. These results will not be reported.

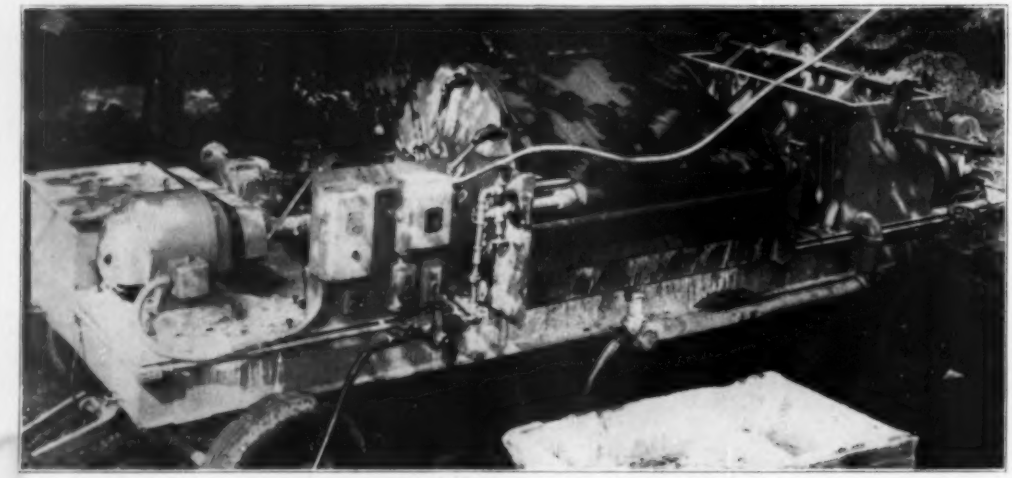
Leaf tests simulating two stage vacuum filtration were undertaken on the sludge from the fibre mill.

Results

The results of the leaf tests on the waste sludge from the sulfite & soda pulp mill are given in Table 1.



Rate of Flow Versus Consistency
(Pressure Filtration of Tissue Mill Sludge)



Komline-Sanderson Portable Coiled Spring Filter Used in Experiments

Results of 57 tests with the one by one foot rotary vacuum filter on the soda mill sludge indicated that at a concentration of 4.4 per cent solids a filter loading of 4.2 lb./sq. ft./hr. can be expected. A change in solids concentration would create an approximately proportional change in filter loading. The cake thickness at this loading is ⅛ inch and the moisture content 76 per cent. Since occasional cover blinding occurred a design factor of say 0.85 would have to be incorporated in the filter loading.

In addition to the above tests, the addition of black ash in controlled amounts gave the results shown in Table 2.

Table 2

Addition of Black Ash Versus Net Filter Loading—Soda Mill

Black Ash as % of Sludge Solids	5	10	20	30	40	75
Number of tests	1	3	3	14	1	1
Average per cent increase in net filter loading	0	6	20	40	70	200

A number of tests were also run at the soda mill adding lime as a filtration aid. The results of eleven tests showed that on an average the net filter loading could be increased 28 per cent by the addition of 5 per cent lime (as CaO) based on sludge solids. Increasing lime (as CaO) to a 10 per cent dosage did not materially improve results.

The results of the pressure filtration tests at the tissue mill are shown in the accompanying graph with rate of flow plotted against sludge tissue. These rates of flow are based on a ½ inch frame with a cake of about 30 per cent solids produced.

Rotary vacuum leaf tests showed a cake consistency of 20 per cent. Since settling tests showed the optimum sludge concentration to be just under 1.0 per cent a rate of about 25 gal. per sq. ft. per day can be anticipated. This is achieved with a cycle of 5 hours of filtration and one hour of down time.

Similar filtration tests on the bond mill concentrate indicated that a 1.0 per cent feed would filter at 100 gal./sq. ft./day. Under this condition, the frame size is one inch, the cake solids content is 42 per cent, and the cycle 3 hours filtration plus one hour down time. Rotary vacuum leaf tests showed a cake consistency of 30 per cent.

For the purpose of testing the fibre mill sludge, a 1.0 per cent sludge was taken. Continuous tube thickener leaf tests on this sludge indicated that it could be dewatered to 5 per cent consistency at the rate of 20 gal./sq. ft./hr. Rotary vacuum leaf tests indicated that the resulting 5 per cent sludge could be dewatered at 1.5 lb./sq. ft./hr. on a rotary vacuum filter, with a ⅛ inch cake produced.

The tissue mill sludge mentioned heretofore was also subjected to thickener leaf tests with results quite similar to the fibre mill sludge results when a 1 per cent concentration sludge was used. The only variance lay in the fact that the two sludges when diluted from 1.0 per cent to 0.5 per cent gave dissimilar results. The flow of tissue mill sludge increased approximately 50 per cent.

The fibre mill sludge did not increase in flow rate. At higher concentrations the rate decreased proportionately with the increase in concentration.

Discussion

Table 1 shows that with the inclusion of the deinking waste decreased the soda and sulfite mill sludge filter loading from 14.4 to 7.6 lb./sq. ft./ hr. with an increase of solids ash content of 25 to 43 per cent. When the mixed waste plus deinking waste was alum coagulated, the filter loading dropped from 7.6 to 1.1 lb./sq. ft./hr. The difficult sludge problem introduced by alum coagulation to integrated mill waste is one of the prime reasons why this method of treatment is recommended for this type of mill[4].

Examination of the soda mill results show that filter loadings are lower than for the sulfite & soda mill, they are still of satisfactory productivity. That they are lower than the soda and sulfite mill may be due in part to the more modern save-all equipment in the soda mill. A strong correlation between sludge concentration and filter loading exists. The correlation is not perfect because the total ash content varies, the ratio of $CaCO_3$ and clay in the ash varies, and the nature of the fiber in the volatile faction varies.

Table 2 shows that the black ash can produce a really significant increase when added in very large quantities. The possible use of this material as a direct addative to the sludge depends upon individual mill

Experimental Use of Sludge from Kraft Waste Lagoon as Fertilizer
(Southland Paper Mills, Inc., Lufkin, Tex.)

conditions. An increase in filter loading is also noted with moderate concentrations of lime, although economical aspects do not favor its continual use.

The pressure filtration tests gave rates of from 25 gal./sq. ft./day for the tissue mill sludge to 100 gal./sq. ft./day for the bond mill concentrate when both were fed at about 1 per cent solids. It is anticipated that most light sludges will dewater in a range closer to that of the tissue mill sludge. The high amount of filler is believed to be the reason for the higher flow experienced with the bond mill concentrate. The cake consistencies produced were about 50 per cent higher than consistencies determined for vacuum leaf tests.

The bond mill concentrate was also subjected to portable rotary vacuum filter tests which, while unsuccessful, point up the part of entrained air in rotary vacuum dewatering. Paper mill wastes are subject to considerable entrainment of air on solids. This can upset clarifying units and conceivably be deleterious to sludge dewatering in some few cases. A good simple visual test for entrained air is to place approximately ½ inch of sludge or white water in a liter suction flask and apply at least 25 inch of vacuum. Where interference in sludge dewatering is suspected, enough deaerated sludge can be collected in this maner for a comparison leaf test.

The leaf thickener tests indicate that the light sludge investigated can be thickened to a point where a dischargeable cake can be maintained at the rotary vacuum filter.

Prior to these tests, these light sludges had been tested with a portable spring filter without success.

As a note of interest, a successful run had been made with the portable spring filter utilizing Bakelite sawdust in the manner of the black ash described before. This material was available in sufficient scrap poundage, but proved too tough for grinding, and this novel approach had to be abandoned.

This fibre mill now intends to install the first continuous vacuum thickener and the first spring vacuum filter installed at any paper mill.

Summary and Conclusions

The results of field testing to determine rates of flow for various means of dewatering of paper mill sludges has been reported in this paper.

Results at integrated pulp and paper mills suggest that rotary vacuum filtration should be feasible for the great majority of these mills. However, any contemplated changes such as internal fiber reclamation must be given consideration in designing dewatering equipment.

At many other mills, and especially where alum coagulation is anticipated as a waste treatment measure, two alternative methods may be given consideration where mechanical sludge dewatering is deemed desirable. These are pressure filtration and two stage vacuum filtration. Pressure filtration offers the advantage of low initial cost, positive action, and a drier cake with the disadvantage of higher operating costs. Two stage vacuum filtration couples high initial cost with lower operating costs, and concurs with the continuous flow principle of waste treatment[5].

Komline-Sanderson Coiled Spring Vacuum Filter Being Installed as Part of Waste Treatment Plant of Continental-Diamond Fibre Co., Bridgeport, Pa.
(The author points to rubber strips which seals off sections under coiled springs)

Acknowledgments

The National Council for Stream Improvement (of the Pulp, Paper and Paperboard Industries) gratefully acknowledges the assistance of the following manufacturers:

Oliver-United Filters, Inc.,
New York
(Manufacturers of the one foot by one foot rotary test filter.)

Komline-Sanderson Eng. Corp.,
Ridgewood, N.J.
(Manufacturers of the portable spring filter.)

Equipment Development Co.,
Monclair, N.J.
(Manufacturers of the continuous vacuum thickener.)

T. Shriver & Co.,
Harrison, N.J.
(Manufacturers of the pressure filter.)

The Council also thanks Mr. Pitkin of Oliver-United for making available test leafs and instructions to Council engineers, and Mr. Smith of Equipment Development for suggesting the test on air entrainment.

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(5) Imhoff, Karl, "The Continuous Flow Principle in Sewage Treatment," Sewage Works Journal 20-629 (July 1949).

Cleveland Awards Contracts for Sewage Works

According to G. E. Flower, Commissioner of Sewage Disposal, Cleveland, Ohio has recently awarded contracts for Overflow Chambers and Spillway Conduit, and Sludge Digestion and Elutriation Tanks. Both contracts are for the Southerly Sewage Disposal Works. The overflow chamber and spillway conduits consists of 1800 ft. of 108-inch reinforced concrete sewer pipe. This contract was for $613,084. The other contract for six separate digestion tanks and two elutriation tanks, with all the necessary appurtenances was for $1,987,359.

SEWAGE WORKS DESIGN REQUIREMENTS

Primary Sewage Treatment: Settling Tanks, Sludge Treatment and Disinfection

The Second of a Series of Articles Based Upon the Current Official Regulations or Recommendations of the Health Departments of Various States.

by
LAWRENCE G. RICE
Consulting Sanitary Engineer
CAMP HILL, PA.

THIS second article contains a composite interpretation of the regulations and recommendations, in regard to the design of primary sewage treatment works, as issued recently by several State Boards of Health. Eight states have issued their particular standards in the last three years and ten others in the preceding five years. These are issued for the purpose of correcting previous faults and for general improvement of new sewage works. They are based upon intimate knowledge and study of many plants under state health department jurisdiction. Combining many states, thousands of plants are represented, and a composite interpretation will represent the most up to date standards in lieu of the fact that there are no general universal standards.

Pollution Limits in Waterways

In streams and waterways, not constituting health hazards, discharges of sewage and wastes should receive at least primary treatment, giving about 55 per cent reduction in suspended solids and about 35 per cent reduction in 5 day B.O.D., but the residual B.O.D. should not exceed 125 ppm. Permits for new plants for primary treatment only are issued to cover present needs. Designs should include provisions for more complete treatment in the future and a site of sufficient area should be provided.

Streams and waterways, considered to be health hazards and used for domestic and industrial water supply, watering stock, ice manufacture, shell fish production, bathing and other recreational purposes, should at all times contain at least 4.0 to 5.0 ppm. dissolved oxygen to satisfy occasional pollution with an additional 4.0 ppm. of dissolved oxygen to support fish life. The pH values should not be outside the limits of 6.5 to 8.5. Sewage and waste effluents discharged, should not affect these minimum standards. The type treatment should give at least an 85 per cent reduction of 5 day B.O.D. and the effluent should not exceed 50 ppm. suspended solids and should have disinfection treatment. Effluents should not cause liberation of gases, such as CO_2 and H_2S to injure fish or aquatic life, or stimulate growths of fungi or other harmful growths, create toxic conditions, cause sludge deposits, scum, oil sleck, turbidity, floating solids, etc., or increase bacterial pollution.

Streams having very small flows and those having small dry weather flows require higher treatment equivalent to activated sludge or intermittant slow sand filters and disinfection.

Permits, when issued to discharge into streams without treatment of any kind, are considered temporary and for limited periods only.

The New England Interstate Water Pollution Control Commission adopted "Tentative Stream Classification Standards" on Feb. 11, 1949. This Commission at present is comprised of three New England States, but two more states have enacted legislation in order to become members of the Commission. All waterways are divided into four classifications depending upon the use of the waterway, and general standards for each classification has been determined. Further study is being devoted to details.

Minimum Dilution Required

One state has recently issued standards for dilution factors necessary for certain types of treatment, expressed in cubic feet per second flows per 1000 equivalent population, as follows:

Effective Sedimentation	3.5 to 5.0 cfs.
Chemical precipitation	2.0 to 3.0 "
High rate trickling filters	1.0 to 2.0 "
Standard or low rate trickling filters	1.0 to 1.5 "
Activated sludge	0.5 to 1.0 "
Intermittent slow sand filters	0.1 to 0.5 "

Table 1 gives the expected efficiency of various types of treatment.

SETTLING TANKS

Aside from coarse screening or passing the sewage through shredders, primary settling tanks are the first treatment units in practically every plant. When combined with disinfection, the treatment is called "Primary." Complete treatment, in addition to primary tanks, includes secondary treatment such as trickling filters, activated sludge etc. and is followed by final settling tanks and disinfection. Intermittent slow sand filters may take the place of secondary treatment and final settling, or may be an addition to complete treatment and follow the final settling tanks where very high treatment is

Table 1
EFFICIENCY OF VARIOUS TYPES OF TREATMENT

	% 5 Day B.O.D. Removal	% Suspended solids Removal	% Settleable Solids Removal
Primary settling	25–40	40–70	90–95
Flocculation and settling without chemicals	40–50	50–75	95–99
Flocculation and settling using chemicals	50–75	70–90	95–99
Chemical treatment followed by rapid sand or magnetite filters	60–85	80–95	
High rate trickling filters 1 stage	60–80		
High rate trickling filters 2 stages	80–95		
Standard trickling filters	80–95	80–90	
Activated sludge	85–95	85–95	
Intermittant slow sand filters	90–95	85–95	

required. Settling tanks may be subdivided into:

(a) Primary tanks with separate sludge digestion.

(b) Primary tanks without separate sludge digestion or "septic tanks."

(c) Primary tanks with both settling and separate sludge digestion combined in the one unit. If not mechanically operated these are called "Imhoff Tanks."

Secondary or final settling tanks are included in Article III.

Primary Settling Tanks

Primary tanks with separate sludge digestion are circular or rectangular flat bottomed tanks with mechanical apparatus to collect the sludge at one particular point for constant or easy removal. Without mechanical cleaning, steeply sloping hoppers are provided where sludge collects at the bottom and is periodically removed from each hopper through withdrawal pipes.

The flat bottom type are generally preferred and in some cases made mandatory, except for small plants designed to serve less than 2000 population. Whether circular, rectangular or hopper bottomed, they have the same general requirements as shown in Table 2.

Table 2

GENERAL REQUIREMENTS FOR SETTLING TANKS

	Avg. Flow Detention Period—Hours	Sett. Rate at Avg. Flow*	Sett. Rate at Peak Flow*
Primary treatment only	1.5 to 2.5	600–900	1200
Before slow sand and standard trickling filters	2.0 to 3.0	600–800	1200
Before activated sludge	1.0 to 2.0	800–1000	1200
Before high rate trickling filters and not including recirculation	1.5 to 2.0	600–800	1200
Same including recirculation	2.0 to 6.0		1200

*Settling rate is in gallons per day per square foot of tank area and should not be outside the range given or exceed the 1200 figure.

Two or more units are to be provided except in the case of small plants. Weir overflow rates in rectangular tanks should not exceed 15,000 gallons per lineal foot of weir per day or may be taken as the equivalent weir length of full length weirs in circular tanks of same capacity.

Rectangular tanks should have a length to width ratio of between 3:1 and 5:1. Inlets should be designed and baffled to distribute the flow evenly over the entire cross section. Scum baffles should be located before the effluent weirs and with special facilities to collect and remove scum, which is generally pumped to the digester. Effluent weirs should be multiple of the H type (except possibly before activated sludge), and have vertical and adjustable sides. The sludge collection hopper walls should have a 45° to 60° slope with the horizontal to the bottom sumps with 60° preferred. The length of travel must be at least 10 feet.

Circular tanks should have specially constructed baffles to break up the entering velocities and to prevent cross circuiting, and, as the limiting length of travel is to be 10 feet, the minimum diameter must be 20 feet. When smaller tanks are required, rectangular tanks are used. Scum baffles and effluent weirs have the same requirements as in the rectangular tanks.

Either type of tank should have sludge lines of 8 in. minimum size with a loss of 4 to 5 feet head allowed when discharged by gravity, but 6 in. minimum size if pumped. Settling tanks may handle only primary sludge or may in addition handle sludge from the secondary settling tanks after trickling filters and the waste or excess sludge from the activated process. Generally sludge is intermittently, but frequently, pumped to the digesters.

The depths of liquid in the tanks may vary from 6 to 12 feet. If there are two or more tanks, the inlets should be designed so that any unit may be shut down for repairs. If there is but one unit, a bypass to the next treatment unit is necessary.

Provisions should be made to drain all tanks completely. Walkways should be installed for convenience in scum collection and at other critical points.

In hopper bottom tanks, the settled matter collects at the bottoms of the steeply sloped hoppers, from whence it is periodically removed to the digesters. Hoppers are not considered suitable if the contributing equivalent population exceeds 2000. Each hopper should have a separately valved outlet and, if drawn by gravity, the sludge lines are to be 8 in. minimum size, and if pumped 6 in. Loss of head to be allowed for a gravity discharge is 4-5 feet. These tanks have all the requirements that apply to the flat bottomed type, except that the hoppers are not included in the computations of the detention period.

These facts are common to all primary tanks. If sewage is pumped directly into the primary tanks, additional allowance should be made for peak pumping rates unless the sewage is pumped at practically the same rate as received. Allowances should also be made in case the maximum flows are unusually high, or if sludge or sewage is recirculated.

Pre-aeration and flocculation with or without addition of chemicals will increase the efficiency of the primary tanks. Many states omit the tank volume below the tops of the scrapers in calculating the detention period.

Septic Tanks

Septic tanks should be of the baffled, flowing through type, with deep scum baffles for retention and digestion of floating matter, and with an allowance of extra depth or with hoppers for retention of settled matter. Septic action is constantly in progress and no attempt need be made to prevent gas and septic matter from contact with the fresh sewage. The efficiency of a septic tank is so low that further treatment is required. The obnoxious gases evolved by the septic action make it mandatory that the tanks must be carefully installed and located to prevent nuisances.

Universally, septic tanks are not approved for municipal work except in very small installations and under exceptional conditions. They are usually used only for dwellings, day schools and small institutions. The total settling capacity is at least 8 hours detention period on average flows, and the sludge storage space at least 2.0 to 3.5 cubic feet per capita. The side depths below the water line should be at least 6 feet. If hopper bottoms are used, the sides should slope to the sumps with angles of 45° to 60° with the horizontal.

Individual withdrawal pipes from each hopper should be provided with valve control; 8-in. minimum size if sludge is withdrawn by gravity and 6-in. if pumped. A loss of head from 4 to 6 feet is allowed if discharged by gravity.

Open tanks may be used in isolated locations but otherwise should be covered with a concrete cover having sufficient manholes to allow proper handling, inspection and removal of grease, scum and settled solids.

Imhoff Tanks

Imhoff tanks are best suited, and in fact recommended, for small plants for populations not exceeding 1000,

and for larger plants where only primary treatment is given, in order to eliminate the high cost of separate sludge treatment. They may be used frequently for larger plants having secondary treatment for the same reason. Imhoff tanks are not well adapted for treatment of some industrial wastes, such as dairy, brewery or cannery or wastes causing an acid condition. They should be located in fairly isolated locations to avoid nuisance from odors, although sealed gas vents may be installed. In cold regions they should be enclosed or housed to prevent freezing.

If large enough, the tanks may be in two or more units with hopper or channel type bottoms. If quite long, provisions should be made to reverse the flow in order to use all the storage space for sludge.

The settling channels should have a combined capacity of at least two to three hours detention period on the average dry weather flow. If preceding trickling filters or sand beds, this may be reduced to 2 hours. If preceding activated sludge, it may be further reduced to 1 to 1½ hours.

Settling channels should have a ratio of length to width of from 5:1 to 3:1, and depth to slot approximately equal to the width. The settling rate should be about 600 gallons per day per sq. ft. area for most cases, but may be increased to 900 gallons when preceding activated sludge or where recirculation is employed. Velocities of flow should not exceed 1 ft. per second.

The walls of the settling compartments should not slope greater than 1.25 vertical to 1.0 horizontal. The bottoms, sloping to the center slot, should be about 60° with the horizontal.

Slots should be at least 6 in. wide with overlap of 6 in. for smaller plants, and 8 in. with overlap of 8 in. for larger plants.

Influent and effluent channels should be designed to have a cleaning velocity. Where the flow is reversed, the channel not in use should be drained.

Inlet baffles should be adjustable and the flow equally distributed across the settling channels and scum baffles provided before outlet weirs. Effluent weirs should be adjustable, and full width or double or H weirs should be used for best efficiency.

Sludge storage compartments should have the following capacities expressed in terms of cubic feet per capita for separate systems as follows:

For primary treatment only—Tanks over 25 ft. deep—1.75.

For primary treatment only—Tanks under 25 ft. depth—2.00.

When storing additional sludge from trickling and sand filters—3.0 to 5.0.

When storing additional sludge from the activated process—4.0 to 5.0.

When the collection system is combined add to the above figures—1.0.

Additional allowances are to be made for trade wastes and when the sewage is unusually strong. Sludge storage capacity is computed as lying below the neutral axis or a plane 18 in. below the plane of the slots.

Sludge compartment bottoms should have a minimum slope of about 1 vertical to 1.5 horizontal to sumps or channel. Division walls should be full length. Hoppers should have individual and valved sludge withdrawal lines with pipes of a minimum size of 8 in. if withdrawn by gravity, or 6 in. if pumped. The valves should be located in manholes outside the tanks if possible.

To start withdrawal by gravity, a head of 4 to 5 feet should be provided. Sludge pipes should be laid with a 3% slope to the sludge drying beds. Pipe lines should be self draining, contain no sharp bends, and have ample facilities for rodding and flushing.

Gas vents should be at least 18 in. wide with 24 in. preferred and have an area of at least 20 per cent of the gross area of the sludge compartment. Convenient walkways are provided to control and remedy scum troubles in gas vents, and for skimming and removal of scum in settling channels. Freeboard of gas vents should be at least 18 to 24 in.

SEPARATE SLUDGE DIGESTION

Sludge, after separation in settling tanks, is pumped to special tanks where the digestion process takes place. These tanks may be open or covered. Open tanks are sometimes used for small plants or where the location is so remote that odors do not cause nuisance. Enclosed tanks with gas collection and disposal are usually used and called digesters.

Digesters may have fixed or floating covers, may be heated or unheated, insulated or not insulated, or only partly insulated. The gases from the digestion process may be burned and wasted, or may be used for any purpose for which illuminating gas is used. The digester capacity depends upon the type sludge treated and the amount of insulation and whether heated or not. The amount of gas eliminated depends upon the temperature maintained in the digesters. All these factors are purely economic for the sludge, when eventually digested, is practically the same.

Digesters need not be in duplicate, but sizes have an economic limit. When two tanks are furnished, they may be operated in series or parallel. If operated in series, digestion takes place mainly in the first tank, and the second used mostly for storage purposes and need not be heated or insulated. When there are more than two tanks, they may be operated in both parallel and series. All digesters should employ forced circulation or mechanical means to break up the scum and trap and dispose of the gas. Digesters should be designed to meet the requirements of standard equipment of the manufacturer.

The recommended capacities of digesters vary with the type treatment employed, the strength of the sewage, with special allowances for industrial wastes and whether heated or unheated. Recommendations are given in terms of cubic feet per capita, which is increased by induction of trade wastes or garbage, as shown in Table 3.

Small tanks require slightly more volume, but if continuous withdrawals are made to storage tanks or drying apparatus, they may be decreased. Sludge pumped directly from the final tanks, or in large volume, will increase these capacities.

Raw sludge pipes should be at least 6 in. size and discharge the sludge into the digesters at locations and levels causing least interference with other operations. Digested sludge withdrawal pipes should be at least 8 in. size, and loss of 4 to 5 ft. should be allowed for a gravity discharge, but may be 6 in. size if pumped. Sludge lines should be as direct and short as possible, without

Table 3
CAPACITY OF DIGESTERS

	Heated cf./cap.	Unheated cf./cap.
Primary treatment only	2.0–3.0	3.0–5.0
Primary treatment with chemicals and flocculation	4.0	6.0
Complete treatment using standard trickling filters	2.5–4.0	4.0–6.0
Complete treatment using high rate trickling filters	3.0–4.0	4.5–6.0
Activated sludge alone	4.0–6.0	6.0–8.0
Complete treatment using activated sludge	3.5–6.0	5.0–8.0

undue fittings and sharp bends, with provisions for rodding and flushing, and laid on a 3 to 4 per cent grade.

Provisions are made to withdraw supernatant liquor at three or four tank levels. The top level should be about 4 ft. below the liquid level, and the other levels successively lower by intervals of 2 to 3 ft. each. The supernatant should be returned to the raw sludge inlet, except in case of activated sludge, where it may be piped to the activated units, and improve activated operation.

Scum and floating material should be mechanically broken up, or equivalent treatment made by recirculation. Enough entrance and inspection manholes should be provided for addition of chemicals to control pH.

Digesters with fixed covers require some gas storage, all openings trapped or sealed, and overflows to maintain a fixed liquid level. Adequate facilities should be provided to sample the tanks at all levels, and inspect the various operations. All openings should be made gas tight, and position indicators also should be provided in case of the floating cover type of tank.

Tanks should be installed with bottoms above ground water level if possible to prevent excessive heat losses. The side walls should be insulated by earth backfill or by other appropriate means of insulation. The completeness of insulation provided may be dependent upon the economic use to which the gas is put.

Means of easy access should be installed. Safety devices, including relief valves for fixed covers, precautions to prevent asphyxiation and explosion proof fixtures, are required.

Gas piping should be at least 2½ in. size, extra heavy genuine wrought iron. For sizes over 4 in., cast iron or steel pipe should be used. Gas piping should slope to sediment and condensate traps at lowest levels, with flame checks, arresters and regulators before burners.

Waste gas burners should be of the all-weather pilot type and located at least 25 feet away from all structures.

Gas boilers are best located above ground in well ventilated rooms. If below ground forced ventilation should be provided. Separate boilers should be used for different fuels. For heating digesters, water should be maintained at 180° and should not exceed 140° in the heater coils inside the digesters. The heater coils should be at least 2½ in. size, heavy wrought iron, cast iron or other noncorrosive material.

SLUDGE DISPOSAL

Drying

After digestion, sludge is usually partially dried to reduce weight and volume for ease in handling and transport, and may be used for fill or for land enrichment. More drying is necessary before incineration, and almost complete drying before grinding and manufacture into soil conditioner. Partial drying may be accomplished by means of sludge drying beds, vacuum filters, centrifuges, roll presses, etc.

In remote locations sludge is sometimes lagooned, or may be used for fill without partial drying.

The area required for sludge drying beds depends upon climate, temperature, rainfall, winds, amount of sunlight, etc. There are so many different recommendations that an attempt is made in Table 4 to give requirements in three classes for favorable, average and unfavorable conditions. The quantities given are in square feet area per capita.

Table 4

Requirements for Sludge Beds

	Open Beds	Glass Enclosed Beds
Imhoff and primary sludge only—		
Favorable	1.0	0.5
Average	1.5	0.75
Unfavorable	2.0	1.0
Primary with chemical precipitation—		
Favorable	1.5	0.5
Average	2.0	1.0
Unfavorable	2.5	1.5
Primary and trickling filters—		
Favorable	0.5	0.5
Average	1.0	0.75
Unfavorable	1.5	1.0
Primary and activated		
Favorable	1.0–1.5	1.0
Average	1.5–2.0	1.25
Unfavorable	2.0–3.0	1.5

Open beds are usually more economical in warm and dry climates. Concrete walls may be used, instead of earth embankment, to prevent wash of earth on the beds. The beds should be subdivided by concrete curbs into separate units, the size of which is dependent upon the size of plant and dosage. Units over 20 feet wide and 100 feet long are not considered practicable. Means are provided for easy handling and removal of sludge, such as walkways, drives or mechanical equipment.

Glass covered beds in wet and cold climates are preferred, due to more favorable drying conditions in winter. The glass housing should be side ventilated with openings inward, and top ventilated with openings outward. Outerwalls and subdivision walls should be of concrete limited in height to 15-21 in. above the sand surface. Sludge should be piped into the drying units in self draining, valved lines with ample provisions for rodding and flushing. Outlets should be about 12 to 18 in. above the sand surface and discharging upon splash plates. Sludge removal may be effected on walkways, by industrial track and cars, or by use of overhead mechanical means. Care should be taken to avoid shading the sand areas if possible, by walkways or high walls.

Drying beds may be both open and enclosed, at the same plant, to offer certain seasonal advantages in operation. Beds should be located as close to the digesters as possible to avoid long sludge lines. Beds may slope to aid in distributing the applied sludge but the slope should be limited to ½ per cent grade. The sand should range in thickness from 4 to 8 in., and consists of clean, washed sand, free from clay and dirt, and have an effective size range from 0.30 to 0.50 millimeters with uniformity coefficient of at least 4.0 to 5.0.

The sand should overlie a layer of well graded gravel, with sizes ranging from ¼ in. at the top surface to 1½ in. at the bottom, and having a depth of 6 to 9 in. above the top of the underdrains. The coarse gravel should be carried down and surrounds the underdrains.

Underdrains should be 4 and 6 in. in size and spaced 8 to 10 feet apart and of vitrified clay with B & S ends laid with open joints.

The effluent from the underdrains should be returned to the primary tanks, secondary tanks or activated sludge units. In any type plant, the effluent should at least receive disinfection treatment.

Where sludge is to be hauled away for land enrichment, covered and elevated storage and platforms should be provided, for ease in handling.

Vacuum Filtration

No specific requirements regarding equipment details are made except that they shall conform to the manufacturers standards and installed according to their recommendations. In general, duplicate filters should be provided, unless there is at least 30 days storage facilities for sludge, or ample digester capacity. The capacity of each unit should be sufficient to process all sludge in five 8-hour days per week. Duplicate appurtenances and wearing parts are to be provided especially when only one unit is provided.

Incineration Requirements

There are no general requirements issued by any state.

DISINFECTION

The effluent should be disinfected for protection of waterways used for drinking water supply, for watering stock, recreation purposes, bathing, shell fish production, ice manufacture, irrigation for vegetables, for small streams and for streams having very small dry weather flow.

Chlorine gas is generally used except that in very small plants hypochlorination is more applicable.

Chlorine may be applied at the inlets of the plants, at various units of the process, and before the contact tank, where sewage receives the final dosage. Besides being used for purposes of disinfection, chlorine may be used for odor control, insect elimination, trickling filter cleaning operations, and to delay septic action. Chlorine contact tanks should have a detention period of sufficient duration to allow the chlorine sufficient time for disinfection purposes but contact times specified vary. Sometimes the secondary tanks, in some types of treatment, displace the contact tanks.

The solution gas feeding type of chlorinator is preferable. Where conditions are critical, or in large plants, two or more units should be provided. If only one unit is installed, duplicate essential and wearing parts are to be provided. The apparatus should be installed in a separate, heated and ventilated room with outside entrance. If interior windows are installed, they should be weather stripped. Fans should be operated from outside switches and gas masks are furnished. Scales to measure the gas are necessary, and means to handle the gas cylinders must be provided. In case ton cylinders are used, special handling and safety measures are necessary.

Chlorine should be added in sufficient amounts to perform the necessary functions and to give a residual chlorine content of 0.5 ppm. after 15 to 20 minutes contact period with the effluent. Provisions should be made to furnish the amounts of chlorine shown in Table 5.

Table 5

CHLORINE DOSAGE REQUIREMENTS

	ppm.
Raw sewage	20–25
After primary treatment only	15–20
After primary with chemical precipitation	20
After trickling filter plants	12–15
After high rate trickling filter plants	15–20
After activated sludge plants	5–15
After intermittant sand filter plants	5–10
For odor control and other uses	10–20

Hypochlorination equipment, when installed, should furnish the same amounts given (in Table 5) and requires duplicate crocks, each having 48 hours storage capacity.

Contact tanks should have a detention period of at least 30 minutes on minimum flows, 20 minutes on average flows and 15 minutes on maximum flows. The chlorine should be thoroughly mixed with the sewage before entrance in the contact tank. The tank should be baffled to prevent cross circuiting and have provisions to drain and clean.

Laboratory Control

Chemical laboratories should contain testing equipment consistent with the type treatment employed, and the various tests and reports required by the State Boards of Health. For simple plant operations, equipment should be furnished for determination of temperature, settleable solids (Imhoff cones), residual chlorine, pH and relative stability. For biological plants, and especially activated sludge plants, drying equipment, incubators, refrigeration, weighing apparatus, apparatus for bacterial and dissolved oxygen and B.O.D. determinations and other special test equipment are necessary.

(The third article in this series will be devoted to secondary treatment and will appear in an early issue.)

Norris Named Exec. V.P. Indianapolis Water Co. Finch, V.P. in Chg. Operations & Eng.

Announcement has been made that Lewis S. Finch, Chief Engr. of the Indianapolis Water Co. since April 1944, has been named Vice-President in charge of Operations and Engineering of the company.

A. O. Norris

L. S. Finch

Mr. Finch became associated with the Indianapolis Water Co. in Feb. 1942, when he was hired as Principal Assistant Engineer. Prior to that time (from 1933 to 1942), Mr. Finch had been in private engineering practice, specializing in municipal water works and sewage problems. Previous to that time he had served as Chief Engineer of the Indiana State Board of Health from 1925 to 1933.

"Lew" Finch, who graduated from Purdue University in 1921, has been Chairman of the Indiana Section of AWWA and has served numerous committees of the section and the national association. Mr. Finch will continue as Chief Engineer of the Company.

At the same meeting of the Board of Directors, Alfred O. Norris, was elected to the position of Executive Vice President. Mr. Norris who came to the Indianapolis Water Co. last year from the Birmingham Water Co. in Alabama as Gen. Manager to replace H. S. Morris, will continue in that position while also acting as Executive Vice President.

As True Today as in Franklin's Day

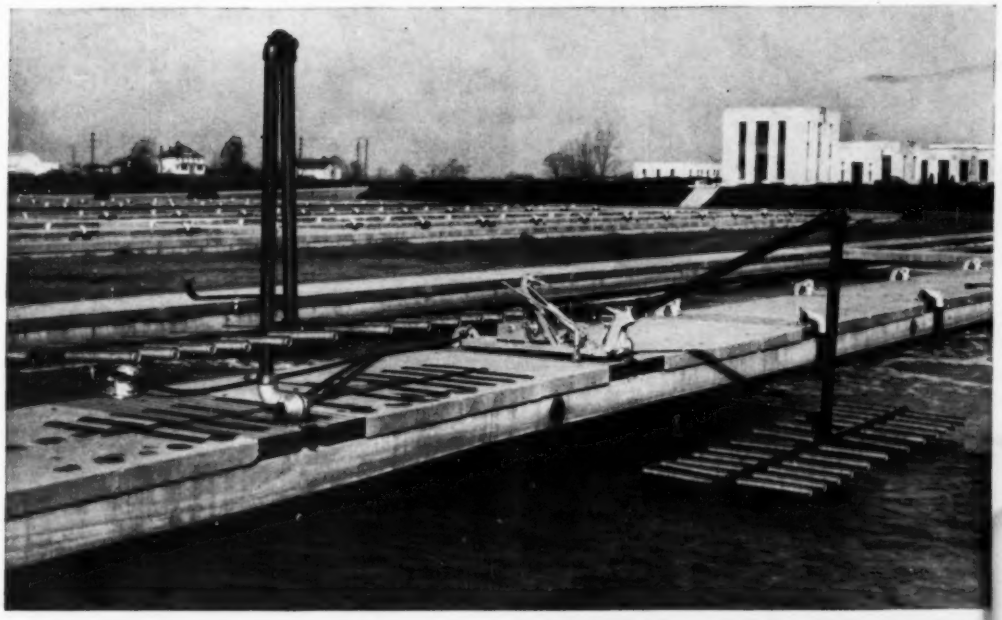
"They that give up essential liberty to obtain a little temporary safety deserve neither liberty nor safety."—*Benjamin Franklin.*

U. of Fla. Third Pub. Health Engr. Conf.

The University of Florida is holding its third national public health engineering conference, on Oct. 23 and 24. The theme of this conference is "Suburban Sanitary Services."

Fourteen topics are to be covered in the conference. Among the topic scheduled for discussion are: Problems Created by Boundary Limitations, The Situation Viewed from the Medical Angle, from the City Officials Viewpoint, and from the County Official's Viewpoint; the Problem of Taxation; Sanitary Districts, City and Surburban Planning, Substitute Measures; Development of Adequate Water Resources for Fringe Areas; and Experiences in Other States.

Chairman of the Conference is John E. Kiker, Jr., Prof. of Pub. Health Engr., University of Florida, Gainesville, Fla. For further information about the conference, registration and hotel accommodations, write to Prof. Kiker.



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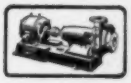

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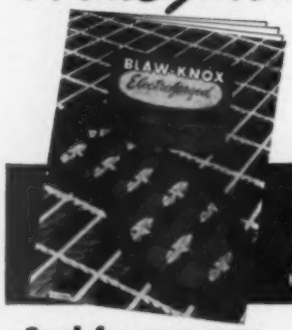

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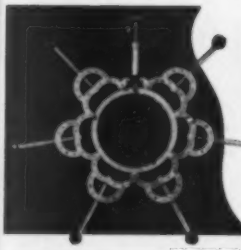


The New Model 4 PILOT PIPE CUTTER for Asbestos—Cement and Clay Pipe

—Easy to Use Saves time and money

Pays for itself on the job. Simply drop on to the pipe, snap one point together ... and you are cutting pipe — fast. There's always another handle within easy reach. Stays sharp ...up to 1000 cuts per blade sharpening.

PIPE CUTTER
Model 4 — Basic Unit
Range 3¼"— 8" O.D.

Wide Range: The basic unit of the Pilot Pipe Cutter handles all classes of 3", 4" and 6" pipe (3½" through 8" O.D.) Range can be increased up to 20" pipe in all classes (25" O.D.) Light weight: just 16 pounds.

$56 freight added

Handle assemblies for increasing capacity ... only $14.00

At your supplier or:

Now you can MACHINE Pressure Pipe in the field, too. Ask your supplier about the new Pilot Machining Tool

PILOT Manufacturing Company
420 MARKET STREET · SAN FRANCISCO 11 · CALIFORNIA
Distributors Wanted • Write for Details

MEETINGS SCHEDULED

OCT. 1-3—ST. LOUIS, MO. (Sheraton Hotel)
Missouri Section A.W.W.A.
Missouri Water & Sewage Conference. Sec'y, Warren Kramer, State Office Bldg., Jefferson City, Mo.

OCT. 4-6—BISMARCK, N. DAKOTA (Hotel Patterson)
North Dakota Water & Sewage Works Conference. Chairman, Edward J. Booth, City Engr., Bismarck, N. D.

OCT. 9-12—WASHINGTON, D.C. (Statler Hotel)
Federation of Sewage Works Associations. Exec.-Sec'y, W. H. Wisely, 325 Illinois Bldg., Champaign, Ill.

OCT. 11—WATERVILLE, ME.
Maine Water Utilities Assn. (Marks the 25th Anniversary of founding of the Assn.) Sec'y, Earle A. Tarr, Supt. Water District, Winthrop, Me.

OCT. 11-13—MOBILE, ALA. (Battle House Hotel)
Alabama-Mississippi Section A.W.W.A. Sec'y, J. L. Snow, 601 First National Bank Bldg., Montgomery, Ala.

OCT. 15-18—NEW YORK CITY, N.Y. (Hotel New Yorker)
American Public Works Association Congress. Exec. Director, Donald Herrick, 1313 East 60th St., Chicago 37, Ill.

OCT. 15-18—NEW ORLEANS, LA. (Roosevelt Hotel)
Southwest Section A.W.W.A. Sec'y, Leslie A. Jackson, Robinson Memorial Auditorium, Little Rock, Ark.

OCT. 16-18—PITTSBURGH, PA. (Hotel Wm. Penn)
Engineers' Society of Western Pa. Chairman, W. J. Murdoch, Hotel Wm. Penn, Pittsburgh, Pa.

OCT. 18-20—PITTSBURGH, PA. (Roosevelt Hotel)
Pennsylvania Section A.W.W.A. Sec'y, L. S. Morgan, 415 First National Bank Bldg., Greensburg, Pa.

OCT. 23-25—CHARLESTON, S.C. (Hotel Fort Sumter)
Southeastern Section A.W.W.A. Sec'y, T. A. Kolb, 433 Wade Hampton Bldg., Columbia, S. C.

OCT. 23-25—MEMPHIS, TENN. (Hotel Peabody)
Kentucky-Tennessee Section A.W.W.A. Kentucky-Tennessee Industrial Wastes & Sewage Works Assn. Sec'y, R. P. Farrell, 420 Sixth Ave., N., Nashville, Tenn.

OCT. 24-27—SAN DIEGO, CALIF. (U.S. Grant Hotel)
California Section A.W.W.A. (Annual Meeting) Sec'y, Wm. W. Aultman, Box 38, LaVerne, Calif.

OCT. 25-26—SPRINGFIELD, ILL.
Illinois Water Works Operators Association. Sec'y, John Briggs, Ass't, Freeport, Ill.

OCT. 25-27—DETROIT, MICH. (Detroit Leland Hotel)
Michigan Section A.W.W.A. Sec'y, T. L. Vander Velde, 2609 E. Saginaw St., Lansing 12, Mich.

OCT. 26-27—DES MOINES, IOWA (Fort Des Moines)
Iowa Section A.W.W.A. Sec'y, H. V. Pedersen, Supt., Water Works, Municipal Bldg., Marshalltown, Iowa.

OCT. 26-28—ATLANTIC CITY, N.J. (Hotel Madison)
New Jersey Section A.W.W.A. Sec'y, C. B. Tygert, P. O. Box 178, Newark, N. J.

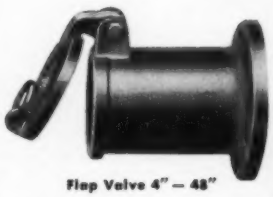
OCT. 30-31—ST. JOHN, NEW BRUNSWICK, CAN. (Adm. Beatty Hotel)
Maritime Water Works Association. (Affiliate of Canadian Section A.W.W.A.) Sec'y, J. D. Kline, 601 Barrington Street, Halifax, N. S.

(*Continued on page* 90A)

LUDLOW = QUALITY + RUGGEDNESS

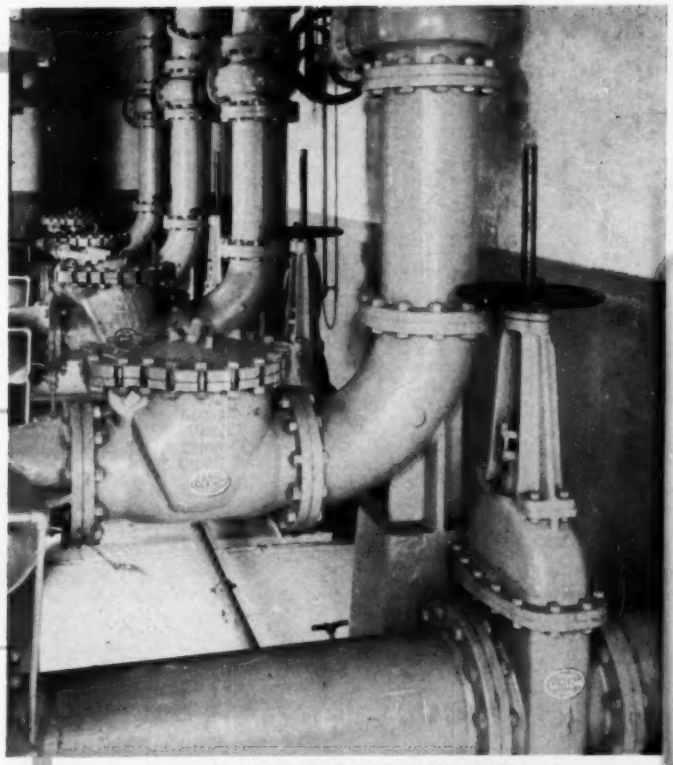
for your Sewerage Equipment

Mud Valve
3" — 16"



Flap Valve 4" — 48"

Shear Gate
4" — 24"



Typical Photograph of a System with **LUDLOW** *Valves in a Sewerage Pumping Station*

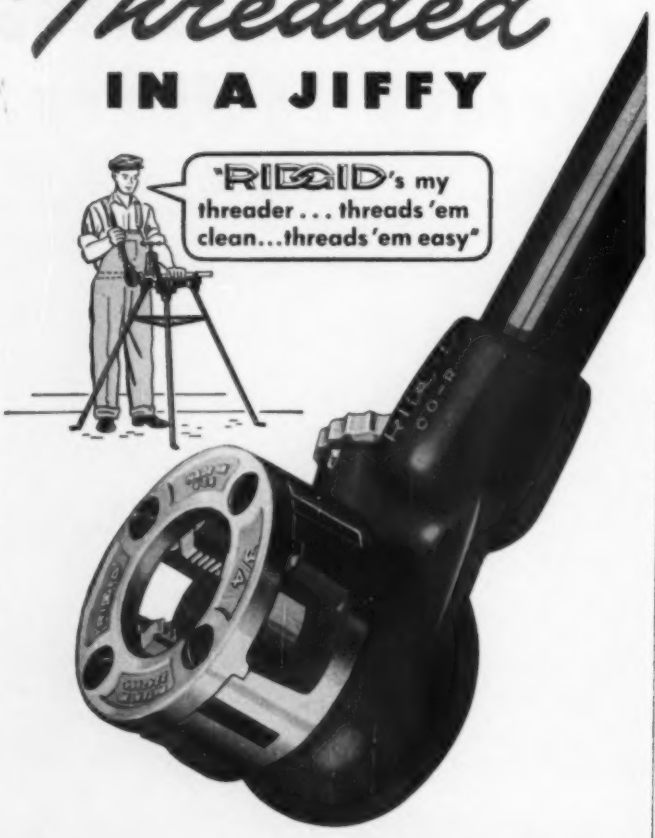
LUDLOW operates a completely integrated plant with its own Iron, Bronze and Steel Foundries — Machine Shops, Pattern Shops — Completely Modern Metallurgical Laboratory and Engineering Department — plus rigid inspection and testing operation control.

The LUDLOW VALVE MFG·CO·INC·TROY·N·Y·

SINCE 1866

TRADE LUDLOW MARK

SMALL PIPE *Threaded* IN A JIFFY



Quick, perfect threads on 1/8" to 2" pipe with RIDGID Nos. 00R, 111R, 12R

● You get ready in a hurry with these light, strong ratchet drop-head dies—just snap in the size die head you want and you're all set for threading. Die heads can't fall out—no special dies needed for close-to-wall work. Precision-cut tool steel dies for smooth perfect threads. Ask your Supply House for work-saver RIDGIDS No. 00R, 1/8" to 1"; No. 111R, 1/8" to 1¼"; No. 12R, 1/8" to 2."

RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL CO. • ELYRIA, OHIO

MEETINGS SCHEDULED

OCT. 30-NOV. 3—ST. LOUIS, MO. (Hotel Statler)

American Public Health Association. Exec.-Sec'y, Dr. Reginald M. Atwater, American Public Health Ass'n, 1790 Broadway, New York, N. Y.

NOV. 1-3—WILMINGTON, DEL. (DuPont Hotel)

Chesapeake Section A.W.W.A. Sec'y, C. J. Lauter, 5902 Dalecarlia Place, Washington 16, D. C.

NOV. 6-7—RICHMOND, VA. (Jefferson Hotel)

Virginia Section A.W.W.A. Sec'y, W. H. Shewbridge, 713 State Office Bldg., Richmond, Pa.

NOV. 13-15—DURHAM, N.C. (Washington Duke Hotel)

North Carolina Section A.W.W.A. and North Carolina Sewage Works Association. Sec'y, E. C. Hubbard, State Board of Health, Raleigh, N. C.

NOV. 12-15—FT. LAUDERDALE, FLA. (Governor's Club Hotel)

Florida Section A.W.W.A. Sec'y, Marvin R. Boyce, 504 Pennsylvania, Clearwater, Fla. (Joint Session with) **Cuban Section A.W.W.A.** Sec'y, L. H. Daniel, Baratillog 9, Havana, Cuba (and) **Florida Sewage Works Association.** Sec'y, Perry Teeple, P. O. Box 210, Jacksonville, Fla.

NOV. 16—BOSTON, MASS. (Hotel Statler)

New England Water Works Assn. Sec'y, Jos. C. Knox, 204 Tremont Bldg., Boston, Mass.

NOV. 30-DEC. 2—TUCSON, ARIZ. (Hotel Pioneer)

Arizona Section, A.W.W.A. Arizona Sewage & Water Works Association. Sec'y, Helen Rotthaus, San Eng. Div., State Capitol, Phoenix, Ariz.

DEC. 13—BREWER, ME.

Maine Water Utilities Association. Sec'y, Earle A. Tarr, Supt., Winthrop, Me.

DEC. 21—BOSTON, MASS. (Hotel Statler)

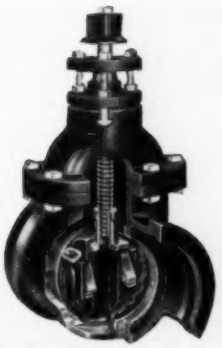
New England Water Works Assn. Sec'y, Jos. C. Knox, 204 Tremont Bldg., Boston, Mass.

IOWA products

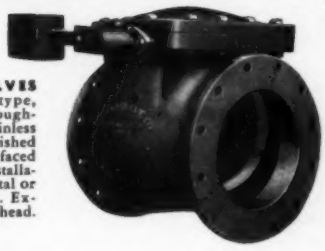
meet your most exacting specification

Superiority of Design, Workmanship, and Materials Assures Efficient Trouble Free Operation . . .

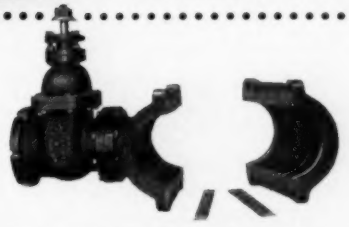
In every job



IOWA GATE VALVES—Simple, rugged construction, fully bronze mounted. Parallel seat, double disc type with independent solid bronze wedges and stem nut. Trouble free service assured.

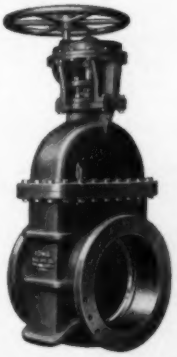


IOWA CHECK VALVES—Balanced swing type, bronze trimmed throughout. Equipped with stainless steel hinge pin. Furnished with rubber or leather faced disc if desired. For installation in either horizontal or vertical pipe lines. Extremely low loss of head.



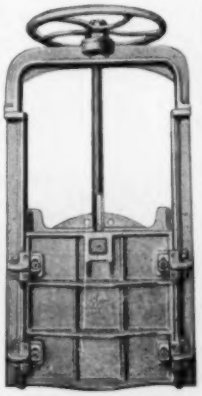
IOWA TAPPING SLEEVES and VALVES—Sturdily built, easy to assemble and center on pipe. All bolted type with lead strips for tight sleeve connections. Extra long body sleeves with heavy flanges amply protect the cut. All sizes available.

IOWA FIRE HYDRANTS—Latest Corey type conforming to AWWA specifications. Will not geyser when standpipe is broken. Unique design provides unrestricted water flow with extreme low loss of head.



IOWA SQUARE BOTTOM VALVES—Specially designed for throttling service in filter wash and pump discharge lines. Square bottom features can be built into gate valves of any pressure ratings.

IOWA HYDRAULIC VALVES—Superiority of design matched with sturdy construction meets severe, continuous filter service requirements. Available with either iron, brass lined or brass tubing cylinders.



IOWA SLUICE GATES—Heavy cast iron construction, fully bronze mounted. Provided with solid bronze adjustable wedges. Suitable for seating and unseating pressures. Wide range of sizes.

Write today for descriptive literature.

IOWA VALVE COMPANY

201-299 N. Talman Ave., Chicago 80, Ill. • *A Subsidiary of James B. Clow & Sons*

SHOPPING FOR BLOWERS?

Look at *R-C dual-ability* with its wide selection to suit almost any job

Asking Roots-Connersville about blowers, exhausters and gas pumps has been standard practice among buyers for almost a century. That's because building such equipment is the only job we do. We're outstanding specialists in handling gas and air.

You'll gain from our wide varieties of sizes, types and capacities from 5 cfm to 100,000 cfm. We're the only manufacturers offering you the *dual-choice* between Centrifugal and Rotary Positive designs—and that *dual-ability* is important when it comes to matching the units to the jobs to be done.

So—when shopping, be sure to call on Roots-Connersville, the specialists. When you're interested in vacuum pumps, meters or inert gas generators, we're equally well fitted to fill these needs, too.

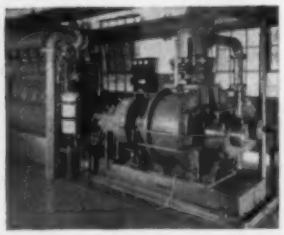
ROOTS-CONNERSVILLE BLOWER CORPORATION
510 Mount Avenue, Connersville, Indiana

CENTRIFUGAL

Installation of 2-stage Centrifugal Blower in southern sewage treatment plant. Capacity 13,500 cfm.

One of two Rotary Positive Blowers, engine driven, in small sewage treatment plant. Capacity of each, 4,750 cfm.

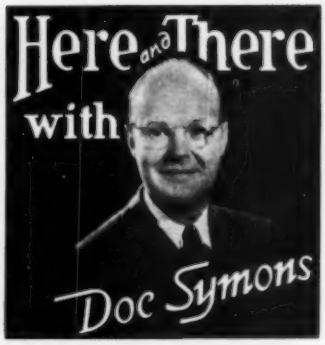
ROTARY



ROOTS-CONNERSVILLE

BLOWER BUILDERS SINCE 1854

ONE OF THE DRESSER INDUSTRIES



Here's That Man Again—And as I sit here on the beach on this beautiful August 27th afternoon, looking out over Long Island Sound at the myriad of white sails, and Long Island itself in the distance, I'm a little sad. It's the end of another summer—and vacation time is over. —By the time you read this, these days will be a fond memory, my faint tan will be diminished to the night club variety, and I'll be seeing many of you Here & There around the country—That's one of the compensations of my work—I meet such interesting people and I love conventions.

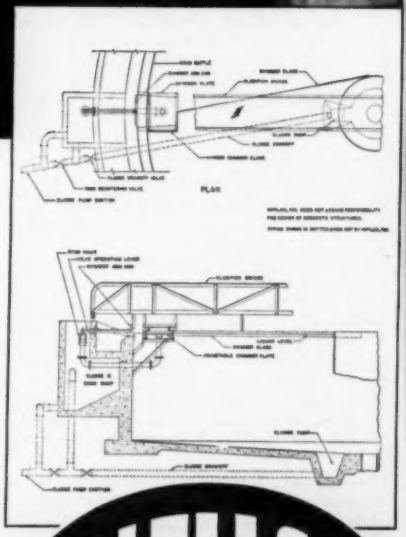
* * *

Of course this past summer wasn't all vacation and as a matter of fact on the last day of my holidays (as my Canadian friends say) disaster set in—my left-handed, or left-sided appendicitis flared up. Aside from feeling lousy with a capital L, and a diet of sulfa drugs, bullion, tea, custards and copious water, it wasn't too bad to lie in bed for five days and sit on the beach for three more —But Broth-err what really hurt was that I had to miss the annual meeting at State College, Pa.—If you've never been to one of those meetings you should plan to go sometime, even if you don't live in Pennsylvania. Besides some mighty interesting papers on water treatment operation and more on sewage and industrial waste treatment, there are a couple of good golf tournaments.

I was particularly sorry to miss this meeting, not only because I'd practiced up on my golf, but because I wanted to attend the testimonial dinner for I. M. ("Mike") Glace.—Mike, you know, is a consulting engineer of Harrisburg and was one of the founders of the Pa. Water Works Operators' Assn. Not only that, but he was Secretary and guiding light for nearly 25 years. Last year he resigned and this year they gave him a testimonial dinner.

(*Continued on page* 94A)

ODESSA, TEXAS, INSTALLATION OF INFILCO AUTOMATIC HYDRAULIC SKIMMER



Controlled Currents Remove Scum this New and Better Way!

INFILCO'S Automatic Hydraulic Skimmer introduces a *new principle* in scum removal. Now, the use of *controlled currents* brings a new high degree of efficiency to the disposal of surface scum in primary clarifiers. The heart of the scum remover is the scum discharge pipe which fits into the center of the skimmer plate located just below the liquid surface. Here, controlled currents are set up to remove surface scum. Removal occurs automatically once during each revolution of the sludge scraper assembly.

WRITE TODAY for Bulletin No. S 6000. It gives all the interesting facts concerning this *better* scum remover. Also complete information about Infilco's "quiescent clarification" . . the ultimate in effective sedimentation and sludge removal.

INFILCO

BETTER WATER CONDITIONING AND WASTE TREATMENT SINCE 1894

INFILCO INC.

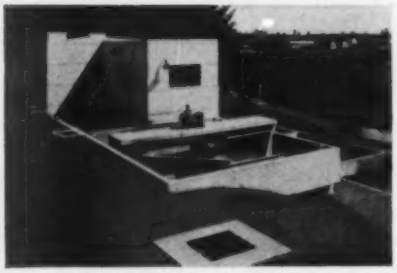
SALES OFFICES IN TWENTY SIX PRINCIPAL CITIES

WORLD'S LEADING MANUFACTURERS OF WATER CONDITIONING AND WASTE TREATING EQUIPMENT

Ideal for small communities, isolated institutions, outlying plants

YEOMANS SEWAGE TREATMENT PLANTS

. . . Activated Sludge Process or Biological Trickling Filter



The "PACKAGE" AERIFIER

Many small communities and outlying institutions, compelled to purify wastes but lacking an ample supply of diluting water, have found in the Yeomans "Package" Aerifier an ideal answer to a critical problem.

Compact, exceedingly efficient in purification, unique for low construction and operation costs, this activated sludge plant provides aeration and final sedimentation in a single concrete unit. Operation is as simple as possible, with supervision limited to routine check-up. Every installation includes final adjustment, initial tested operation, thorough training of operators and continuing counsel from Yeomans engineers.

"WATER-WHEEL" DISTRIBUTOR

Operating in conjunction with a primary sedimentation tank, the Yeomans "Water-Wheel" Distributor applies settled sewage to a trickling filter—with unfailing dependability. Sewage flows into the rotating trough, and is spread evenly on the filter bed through V-notches and spreader plates. The trough is actuated by a water-wheel and bevel gearing. Filter beds range from 5-foot to 25-foot diameters; and the entire area is effective for treatment. Continuous positive distribution is assured at all rates of flow—which does away with need for dosing chambers and siphons. There is none of the clogging and cleaning of spray nozzles often required with reaction distributors; and elimination of accessories saves as much as the entire cost of the complete Water-Wheel installation. Maintenance is extremely simple. Numerous Water-Wheel plants—small communities, hospitals, airports, industrial plants—provide impressive proof of this unit's extraordinary efficiency.

Helpful engineering data on these Yeomans plants will be sent promptly upon request—no obligation.

YEOMANS

PUMPS FOR BUILDINGS, MUNICIPALITIES, INDUSTRIAL APPLICATIONS—
and a complete line of Sewage and Waste Treatment Equipment

Yeomans Brothers Company
1423 North Dayton Street, Chicago 22, Illinois

Please send information as follows:

☐ **Yeomans "Water-Wheel" Distributor**

☐ **Yeomans "Package" Aerifier**

Name_____

Address_____

City_____ **State**_____

(*Continued from page 92A*)

A great number of Mike's friends also contributed a goodly amount of money to establish an I. M. Glace Fund—not for Mike—but in his honor to establish prizes for the best operators' papers. And, in addition, a bunch of the boys chipped in and bought Mike a beautiful set of golf clubs.—Yessir . . . I wish I could have been there to see Mike Glace receive them.

I don't know of any greater accomplishment a man can gain than to have so many, many friends—I've kidded Mike in and out of this column, many times, but I'm glad to be counted as one of his friends—I just wish I could play golf and bridge as well as he does!

* * *

A note from "Bob" Ingols tells me he is on six months leave of absence from Georgia Tech., and is now a Research Fellow of the Oak Ridge Institute of Nuclear Studies and will be there until the end of the year.

Bob also tells me that two other Sanitary Engineering Profs have been there, this past summer, studying the use of radio-active tracer elements for research. They were Profs. Harold E. Babbitt of the Univ. of Illinois (my old home U) and "Gerry" Ridenour of Univ. of Mich.

* * *

Shortly after my August column appeared (in which I once more raised voice against the inhuman clothes we men have to wear in the summer) I received this note from "Sid" Anthony, Supt. of Water at Augusta, Me., to wit: "Dear Doc—See page 88-A of August issue, then tell me where you can appear with no more apparel than you mention. You got down to the belt, but what, if anything comes South of that ????"—As if you didn't know, Sid.

* * *

Never let it be said that I don't like to see my name in someone else's column—And here's my thanks to Jack (Sparling Meter) Service who does a particularly good house organ, "Sparling Metrograms"—Nice to see you, too, Jack.

* * *

When I wrote the story (with pic) of St. Paul's Milt Rosen at the AWWA Convention Water Well, I tagged him from Minneapolis and only Enslow's sharp eye saved me the embarrassment that every one has when mixing up those two cities. Reminds me of the session at the Philadelphia meeting, when Art Kuranz, that whiz kid from Waukesha, got

(*Continued on page 96A*)

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •

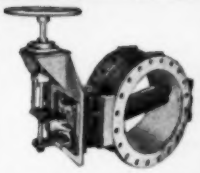
R-S FLOAT VALVE for Sewage Service

The R-S Heavy Duty Direct Action Float Valve controls the water level in a wet well of a sewage treatment plant at Quakertown, Pennsylvania. Illustration shows valve approximately 25% open. At the high level, practically drip tight shut off is obtained with metal-to-metal seat. The adjustable float connection keeps the float away from the area of turbulence.

R-S Valves are used in air, gas, liquid, steam and semi-solid service for the shut off and regulation of volume and pressure, pressure relief, liquid level control, back pressure, water hammer, steam hammer, constant differential pressure, output control of pumps, fans, engines, turbines and automatic combustion. Suitable for service in the temperature range from minus 300°F to plus 2000°F. 2 to 2500 psig.

Specify R-S Valves for simplified control and shut off. Consult with your local R-S Valve Engineers or write direct.

R-S PRODUCTS CORPORATION
Wayne Junction • Philadelphia 44, Pa.



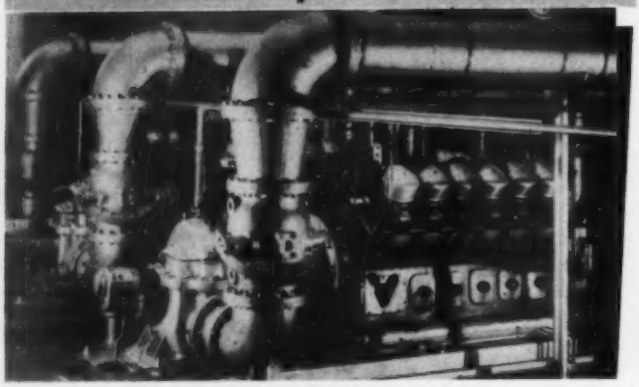
No. 700—20-inch 50-pound Cast Iron Valve with rubber seat, Type B-8934, for positive 100% shut-off. Heavy duty handwheel control with threaded reach rod. Type B-9469.

No. 781—Fourteen-inch Heavy Duty Cast Iron Valve with 125-pound American Standard flanges and drilling. Mounting bracket, crank arm, reach rod and linkage together with springless diaphragm top including positioner, gauge and an auxiliary tank as an integral part of the unit. Should all air fail, pressure in the tank will stroke the valve. Note the bronze bushings in bracket through which the air motor shaft passes.

No. 780—Eight-inch Off Center Valve for control of 15 psig saturated steam with 1 psi drop. Series 15, 150 - pound American Standard raised face flanges. Double crank arm with adjustable weights for accurate setting. Cylinder is not an actuator but simply a dash pot. Note 2-inch flanged outlet for overload relief.

No. 782—Heavy Duty Wafer Type Valve, rubber seated, 5° angle seated vane with enclosed gear reduction drive. Note that there is plenty of room to easily remove the gland and repack the stuffing box.

N.Y.C. selects Le Roi Engines for Water-System Modernization



3 Le Roi 600 HP engines provide 21,000 gpm standby capacity for 179th St. Pumping Station

Here's why New York City chose Le Roi L3460's to power the three 7000 GPM single-stage pumps in the pumping station which supplies water to the 100,000 residents of the Washington Heights area:

1. **Greater Power** — L3460 engines are the most powerful units of their kind — producing 600 HP maximum.
2. **Lower Cost** — these 600 HP gas engines cost only ¼ to ½ as much as diesel engines of equal power.
3. **Easy Operation** — L3460 engines operate on natural gas or gasoline. They're dependable, they start quickly, and warm up fast. That's why they are ideal for standby service.

Le Roi engines are available in sizes ranging from 6 to 600 hp — custom generator sets in sizes from 30 to 300 KW. Lighten the tax load in your community. Use dependable, low-cost Le Roi power. Send the coupon below for a detailed report of this and other money-saving installations.

LE ROI COMPANY
Milwaukee 14, Wisconsin
New York • Washington • Cleveland • Birmingham
Milwaukee • Tulsa • Butte • San Carlos

Tear out this coupon and mail TODAY!

LE ROI COMPANY, Milwaukee 14, Wisconsin
Please send me complete information on the New York City Le Roi engine installation plus other cost-cutting job reports.

Name .....
Title .....
Address .....
City ..... ( ) State .....

E-6n

(Continued from page 94A)

up and said something about Len (Past Pres. AWWA) Thompson of Minneapolis. Len was on his feet in a hurry to say he was from St. Paul.

* * *

Speaking of Art Kuranz, Waukesha's Utilities Manager, also reminds me of the Wisconsin Section Picnic held at Jimmy Meyers' in Wayne, Pa., during the AWWA Convention in May. I've told you that story before, but, I didn't tell you that it was Ted Rudgal who drove me out to the affair. On the way Ted said he had to hurry back because he was going to the Volunteer Fireman's "Shindig" that night. Seems Ted used to be one of the "fire eaters" when he lived in Pennsylvania. At that time he worked with George Mebus' father. George, you know, is a consulting engineer in Glenside, Pa., and hadn't seen Ted (Harold) Rudgal since he (Ted) went west to become a Badger.

* * *

Still at the Philly Convention, I stopped by the R. B. Carter Co. booth, and John (Sales Manager) Horgan introduced me to one Doug. L. Blaik, Mfrs. Agent of Cleveland, Ohio. Mr. Blaik, who is the brother of the famous "Red" Blaik of West Point, had a complaint. Seems some magazine in this field had reported his death a while back.—It wasn't us, was it, "Doug,"? I know you're very much alive.

* * *

Things I'd like to know—Is there a saying "Straight as a die" and if so where does it come from?

* * *

Just to prove to some of you skeptics who think I can't take a good picture of anyone, I'd like to submit the following taken at the Hotel Gibson, Cincinnati, during the Ohio Sew. & Ind. Waste Treat. Conf. meeting in late June.

This is Ken Watson's Mrs. (hubby's Asst. Dir. of the Ohio Compact Commission)—and the man with the approving look is none other than H. W. Streeter, of the U.S. Pub. Health Serv. (Retired).

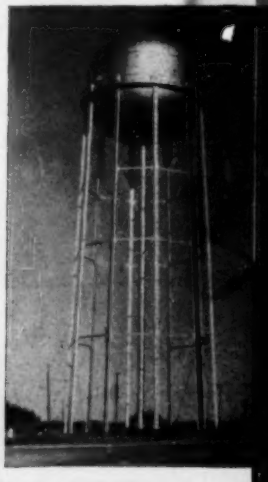
(Continued on page 98A)

WHERE *Appearance* COMBINES WITH *Economy*

PITTSBURGH • DES MOINES

Double-Ellipsoidal *Elevated Steel Tanks*

Over a wide range of capacities up to a million gallons, the Pittsburgh-Des Moines Double-Ellipsoidal design offers low investment cost, excellent appearance and economical performance. It is one of the several P-DM Elevated Steel Tank types, meeting every water storage requirement.



Write for your free copy of our latest 24-page brochure, detailing many important aspects of modern water storage.

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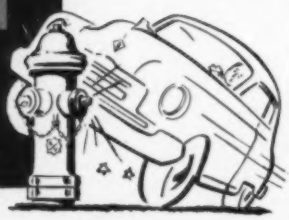
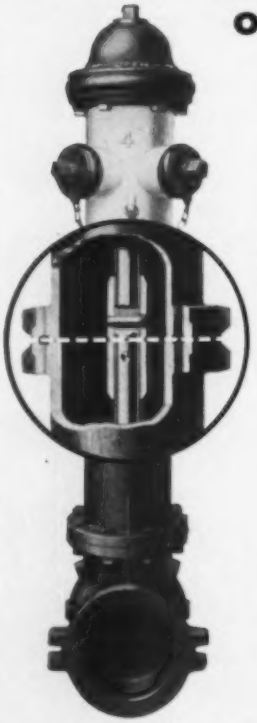
KENNEDY SAFETOP



The Hydrant that Cuts the Cost of Traffic Accidents



Wherever a fire hydrant faces the hazards of traffic . . . the community is safer, maintenance is lower, when it is a KENNEDY Safetop.

The whole secret is in the Safety Breakable Section (see enlarged inset on illustration). Notice the standpipe breaking ring. It has been so engineered that its strength is equal to that of the standpipe wall itself. This means that a KENNEDY Safetop Hydrant will stand up without breaking under any ordinary impact. But . . . the stresses are so distributed that when the breaking point is reached it breaks cleanly at the groove in the breaking ring.

The inexpensive stem coupling and breaking ring are the only parts to break . . . above ground where they are easily and quickly repaired. There's less damage to the car that hits it. Repair costs are a fraction of a below-ground break or of a fractured standpipe. The neighborhood does not risk curtailed fire protection for a protracted period.

ONE MAN in less than fifteen minutes, can permanently repair a KENNEDY Safetop Fire Hydrant broken in a traffic accident. A wrench, sledge hammer, screwdriver and a collision repair kit, consisting of a new Standpipe Breaking Ring, a new Stem Coupling, 2 pins and a gasket, are all he needs!

Send for your copy of ***Safetop Bulletin*** 1036

THE KENNEDY VALVE MFG. CO.
1036 EAST WATER ST.
ELMIRA, NEW YORK
VALVES • PIPE FITTINGS • FIRE HYDRANTS

OFFICE-WAREHOUSES IN NEW YORK, CHICAGO, SAN FRANCISCO • SALES REPRESENTATIVES IN PRINCIPAL CITIES

(*Continued from page* 96A)

Fellow by name of Kittrell, F.W., who serves as Chief of Stream Sanitation Sect. of the Tenn. Valley Auth., sometimes does a bit of convention reporting for us. This year it was the AWWA Water Resources Div. sessions at Philadelphia.—"Kit" has learned a little about how an editor works, as witness this letter which he sent with his report.

"Dear Doc—Doubt that even you, in all your peregrinations, ever completed an assignment under more varied conditions than I have this one. As soon as I got back from Philadelphia, I had to hit the road . . . on a special rush job. Have carried the notes on the Wat. Res. Div. sessions in my brief case to Nashville, Raleigh, Atlanta, Montgomery, Jackson, Chattanooga, Richmond and Louisville. Have worked on writing up the notes in: The Robert E. Lee (suh!), the Andrew Johnson, and several other hotels from second to fifth class; on American, Capital, Eastern, and Delta planes high over the Cumberland Plateau, the Smoky and Blue Mountains, the Highland Rim of middle Tennessee, the rolling hills of central North Carolina, the flat country of Georgia, Alabama, and Mississippi, and some of the reservoirs of T.V.A.; in airport waiting rooms, in state health dept. offices, at home at night, and in fact almost everywhere except my office."—Now you know how it's done, "Kit."

My past catches up with me.—Down Cincinnati way at the O.S. & I.W.T.C. I ran into a one time student of mine (Good old Univ. of Ill.) by the name of Dave Seidel. Had his Mrs. with him as you can see by the accompanying shot. We both took one

look at each other and reached for a hat, under which to look younger. —Dave is now associated with Floyd G. Browne & Assoc. of Marion, Ohio.

* * *

This is old news now, but last July "Joe" Schwada, AWWA Diven Medalist and former City Engineer of Milwaukee, had a touch of being under the weather, but wouldn't say what

(*Continued on page* 100A)

Threshold Treatment with CALGON* stabilizes dissolved iron and manganese

"Red Water" complaints do not necessarily mean that active corrosion is occurring in a water system.

In unfiltered well waters such complaints may be caused by the oxidation and subsequent precipitation in the mains of iron present in the water at its source. A concentration of only a few tenths of a part per million can cause difficulty because the sludge will build up in the mains and eventually be carried through to the consumer.

Threshold Treatment with Calgon, however, will prevent the precipitation of hydrous ferric oxide upon exposure of an iron-bearing water to air or even to free residual chlorination. When so treated, the water will remain clear throughout the system. The water will be colorless, for all practical purposes, and will not stain clothes or textiles processed with water.

The treatment is equally effective in regard to manganese-bearing waters, which are the source of "black water" complaints.

For more detailed information on the use of Calgon in stabilizing dissolved iron and manganese, fill out and mail the coupon below or write us concerning specific problems in which you are interested. Calgon technical representatives are at your service.

CALGON, INC.
Hagan Building, Pittsburgh 30, Pa.

Please send me a copy of your bulletin, "Calgon Stabilizes Dissolved Iron and Manganese."

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POSITION.....

COMPANY.....

STREET AND NUMBER.....

CITY.....ZONE.....STATE.....

*T.M. Reg. U.S. Pat. Off.

HAGAN HALL BUROMIN CALGON

calgon, inc.

A SUBSIDIARY OF HAGAN CORPORATION

HAGAN BUILDING PITTSBURGH 30, PA.

(Continued from page 98A)

it was. As you know, Joe is now Civil Defense Engineer for the City of Milwaukee, a post he was appointed to last April after 27 years as City Engineer.

* * *

E. Sherman Chase, Consulting Engineer of Metcalf and Eddy, Boston, sent me a newspaper clipping on the Bradley Field Sewage Plant at Hartford, Conn. "Sherm" pointed out in his letter that the plant was designed, "but not named," by M & E engineers. According to the newspaper caption there is a "Twinkling Filter Bed" at this plant—Maybe the photographer caught a glimpse of the reflected sunlight on the discharge from the rotary distributor—or something.

* * *

Shades of the old home town—who should turn up at the Jamestown, N.Y. meeting of the NYS&IWA (that's New York Sewage & Industrial Waste Assn.) but a bunch of the boys from Buffalo.—Of course, Johnnie (B.S.A. Gen. Mgr.) Johnson was President of the organization, and George Fynn, Chief Chem. was there, (but not Buffalo "Bodie" Ketcham) and then John J. Joyce, Jr., Exec. Secy., was on the program, and brother "Bill" Joyce (who masterminds the Chamber of Commerce in Jamestown, now) put on the entertainment at the banquet.—And just to show you that those Joyce boys are still clowning, here they are—John, left and "Bill," right.

* * *

You all know W. F. Schaphorst, M.E., of Newark, N.J. as the man who contributes, to this magazine, so many interesting and useful nomographs, kinks, and gadgets. Mr. Schaphorst also has an eye for humor as well. He too, realizes the many vagaries of the English language and submits this story to show what can happen when you get caught with your syntax down.

"A mid-west minister had been seriously injured by falling from a tree he was trimming. For two weeks he hovered between "Here" and "There" during which time his condition was reported to his parishoners daily on the church bulletin board. Finally this report appeared: 'God is good; our minister is better.'" Thanks, W.F. ——

* * *

A year or more ago Ed Shroyer, Supt., Westinghouse Plant in Fairmont, W. Va., had a new paint job at his plant. According to the story in the W. Va. Sew. Assn. News—"Some kind soul discharged several hundred gallons of lacquer into the sanitary sewer". Presto—Ed had the only lacquered Imhoff Tank in the country. Wonder if "saving the surface has saved all?"

* * *

Now that summer is over and the crisp days of fall are here, I'll unlimber a hat again—and who knows they might let me visit Danbury, Conn.—with or without benefit of headgear (and hair). I'm looking forward to another mighty interesting season—and first on my schedule is the NEWWA meeting at Poland Spring—I had several other places I wanted to go in September but the orders are take it easy for awhile. —How about some letters, fellows, since I won't be able to see too many of you before you read this and I'll need some material about then.—How about it—hmmmm???

V.T.Y. — Doc

Easy to lay MECHANICAL JOINT

M & H VALVE AND FITTINGS COMPANY
ANNISTON, ALABAMA

Our Mechanical Joint Valves, made to AWWA specifications, are furnished in sizes 2" to 30", and valves approved by Underwriters and Associated Factory Mutuals are furnished in sizes up to 12". Iron body, bronze mounted, double disc, parallel seat, hydrostatically tested at 350 lbs. for water working pressures of 175 or 200 pounds. Post Indicator Valves with Mechanical Joint feature are available for use with indicator posts when valves are installed on underground pipe line to serve sprinkler system requiring Underwriters and Associated Factory Mutual's acceptance.

Mechanical Joint features are: Ease and speed of installation, construction economy, joint deflection, leak-tight, long life. Used with AWWA Class A, B, C, D; Federal Spec. WW-P-421; or Class 100, 150, 200, 250 centrifugal pipe.

Figure No. 82M

WRITE FOR CIRCULAR NO. 49

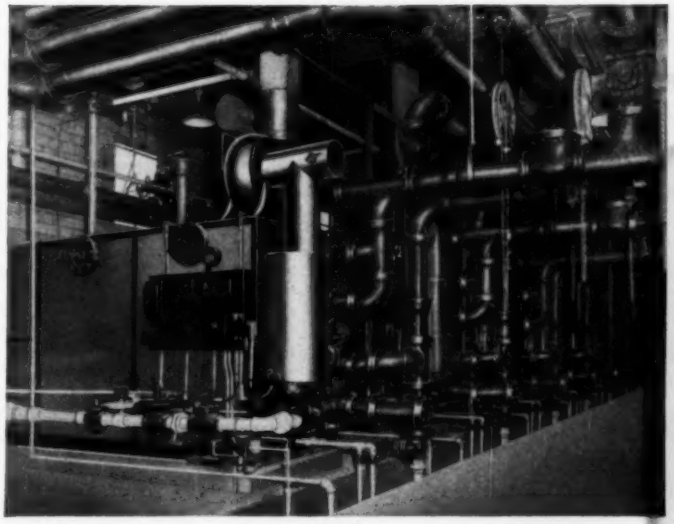
Our new Circular 49 gives important information and installation dimensions of M & H AWWA Mechanical Joint Valves and Hydrants . . . . . Underwriters and Factory Mutual approved Post Indicator Valves . . . . . and Cutting-In Sleeves.

M & H Products · Everywhere

8 P.F.T. DIGESTER HEATER AND HEAT EXCHANGER UNITS FOR AKRON, OHIO

UTILIZING SEWAGE SLUDGE GAS, THEY WILL PROVIDE DIGESTER HEATING AS WELL AS BUILDING HEATING.

OVER the World, the busy and progressive city of Akron, Ohio, is known as the Tire Capital. Recent additions to its Sewage Treatment Plant include eight P.F.T. Digester Heaters and Heat Exchanger units. Four are arranged for either gas or oil firing and four are equipped for gas only. The flexible piping system allows for preheating of raw sludge simultaneously with the heating, by recirculation, of the contents of any one of six digesters. Total output capacity for digester heating is 8,000,000 B.t.u. per hr., with maximum heating capacity of 12,000,000 B.t.u. per hr.



OTHER P. F. T. EQUIPMENT INCLUDED IN PLANT ADDITION

Akron joins a long list of cities that have been assured positive, trouble-free heating of digester contents. P.F.T. Digester Heater and Heat Exchanger units maintain ideal temperatures in the digester assuring peak bacterial action. The Akron expansion program includes six P.F.T. Floating Covers to fit 95' 0" diameter tanks, six P.F.T. Cover Position Indicators, six P.F.T. Supernatant Selectors, and Gauge, Sight Glass and Sampler Units and P.F.T. Gas Safety Equipment.

Additions to the sewage plant were designed under the direction of the City of Akron, Weldell R. LaDue, Chief Engineer and Havens & Emerson, Cleveland, Ohio, Consulting Engineers. The Akron plant also includes P.F.T. Equipment in operation since 1926 on trickling filters, comprising fourteen 36" Twin Dosing Siphons and Nozzles.

P.F.T. PACIFIC FLUSH TANK CO.

SEWAGE TREATMENT EQUIPMENT EXCLUSIVELY SINCE 1893

4241 RAVENSWOOD AVENUE CHICAGO 13, ILLINOIS

NEW YORK • LOS ANGELES • SAN FRANCISCO • CHARLOTTE, N. C. • DENVER • TORONTO

THE SPILLWAY

[Overflow from the main section]

Annual Reports Of Interest

The following brief abstracts have been made of annual reports received within recent months. Copies of the reports may be obtained by writing to the superintendent of the department or plant in question.

WATER & SEWAGE

KENOSHA, WIS., 1949 Water & Sewage report, (52 pages), H. T. Rudgal, Supt. New services constructed 229, new accounts added 569, total services in system 13,570. New meters installed 569, total meters in system 12,240. Water delivered to distribution system 2,723,715,000 gal. This was to a population of 56,000 showing a per capita consumption of 133.3 gal. per day. Percentage of income was up 16.1% over 1948 and percentage of operating expenses was up 15.1% over the same period. Charts show bonded indebtedness, daily pumpage and monthly variations in water pumped during past 10 years.

The sewage report shows that 4,144,129,000 gallons of sewage were pumped and treated and 3,419,860 pounds of putrescible matter as dry solids were removed. The 11,400,000 gallons daily average was 14% above the design load. In this section charts show daily sewage flow, amounts of dry solids removed, sludge gas produced and pounds of solids pumped to digesters, digester data, weather data and general operating data.

ALLIANCE, OHIO, 1949 Water & Sewage report (68 pages mimeograph), Donald D. Heffelfinger, Engr.-Supt. Water pumpage 5.11 mgd. Water income totaled $254,866-.42. Sewage fund receipts amounted to $48,072.16. Expenditures for water $232,670.21, sewage treatment $26,-885.59, sanitary sewer fund $40,371-.10. 68.6 per cent of water pumped was metered. During the year 135 new services were added, 2,283 feet of water mains laid, 11 valves installed and 5 hydrants set.

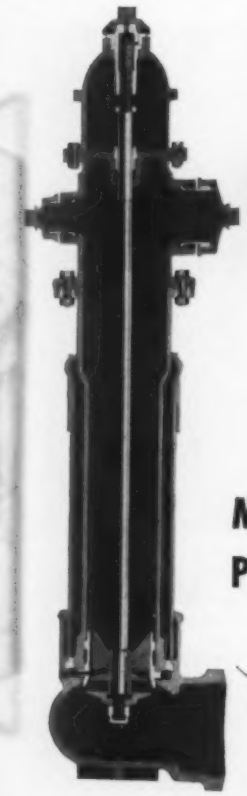
Sewage flow averaged 2.31 mgd. Removal of 83.8 per cent of suspended solids and 84.8 per cent of the B.O.D. was effected. The forest planting project planted two thousand white and red pines.

WATER SUPPLY

LITTLE ROCK, ARK., 1949 (71 pages), L. A. Jackson, Manager-Engineer. New Construction: 17 miles of additional reinforcing and grid water mains were added, 66 new fire hydrants installed, 1,171 new services were installed, varying in size from ¾ inch to 4 inch. Meter installations totaled 1,366 and at the end of the year, there were 26,947 meters in service. Illustrations of plants and the city of Little Rock along with tables on the characteristics of the water, temperatures, annual rainfall, etc. are shown. Expenditures show that 24.46% went for capital expenditures, 11.26% for bond retirement, 8.03% for general, 7.06% for distribution, 5.96% for commercial, 2.15% for water source, 1.84% for pumping, 4.37% for privilege tax, 0.88% for miscellaneous, 22.72% for fixed charges, 5.18% for purification and 6.09% for depreciation.

PORTSMOUTH, VA., 1949 (27 pages), X. D. Murden, Supt. Report

(*Continued on page* 104A)



MATHEWS HYDRANTS

MECHANICAL JOINT PIPE CONNECTIONS, TOO

Because more and more people are using the mechanical joint pipe, it seems advisable to remind our customers that we supply hydrants with this type of connection—gate valves also.

Made by R. D. Wood Company

Public Ledger Building, Independence Square

Philadelphia 5, Pa.

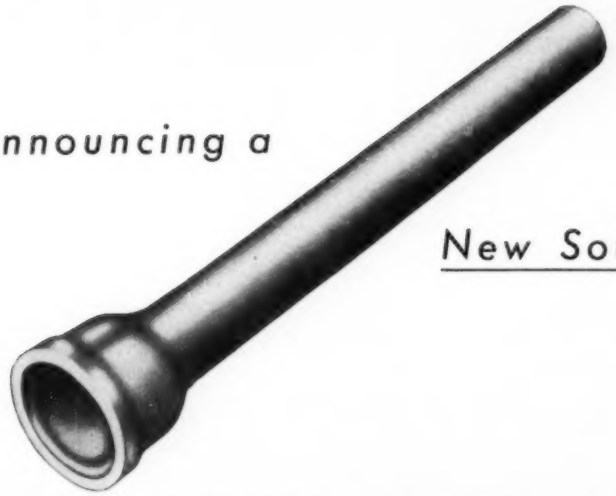
Manufacturers of "Sand-Spun" Pipe (centrifugally cast in sand molds) and R. D. Wood Gate Valves

THE FIREMAN'S FRIEND

Mathews Modernized Hydrants Set the Pace: All working parts contained in replaceable barrel • A broken Mathews can be replaced with spare in a jiffy, without excavating • Stuffing box cast integral with nozzle section • Head can be turned 360° • Replaceable head • Nozzle sections easily changed • Nozzle levels raised or lowered without excavating Protection case of "Sand-Spun" cast iron for extra strength, toughness, elasticity • Operating thread only part to be lubricated • A modern barrel makes an old Mathews good as new

Announcing a

New Source of*



CAST IRON PRESSURE PIPE

Made by the Tried and Proven De Lavaud Principle

*A new source serving 9 states that operates its OWN ore and coal mines, makes its OWN pig iron, manufactures its OWN pipe

Lone Star Steel has every facility to bring you the highest quality Cast Iron Pressure Pipe for gas, water and sewer systems. It operates its own ore and coal mines. It makes its own high grade pig iron. These factors guarantee complete control of manufacture for uniformity and high quality. Lone Star Steel Cast Iron Pressure Pipe is centrifugally cast and annealled under Federal Specifications WW-P-421. It is non-contaminating, resistant to rust and corrosion, immune to heat and will last for centuries. Either plain or cement lined.

Lone Star's geographical location means a substantial saving to customers between the Rockies and the Mississippi in freight rates.

LONE STAR STEEL

LONE STAR STEEL COMPANY

The Only Cast Iron Pressure Pipe Plant between the Rockies and the Mississippi

Executive Offices
DALLAS, TEXAS

Coal Mines
McAlester, McCurtain
OKLAHOMA

Ore Mines, Beneficiation Plant, Blast Furnace, Coke Plant
LONE STAR, TEXAS

(Continued from page 102A)

shows that more than 3½ billion gallons of filtered water were pumped in 1949; 51,364 feet of mains constructed; and that 670 new meters were placed. Graphs and tables on pumpage, operating and interest charges, cost of water pumped and information regarding the work of inspectors, source of supply, pumping stations, purifications and personnel records are included.

AUGUSTA, MAINE, 1949 (48 pages), Sidney S. Anthony, Supt. & Eng. Auditor's report shows exact financial statement for year of 1949. The income (each $100.00) shows $54.39 from residential sales, $10.94 from commercial sales, $12.64 from sales to industry, $13.89 from sales to governments, $7.33 from fire protection and $0.81 from miscellaneous. Expenditures (each $100.00) shows $26.41 for additions to plant, $18.25 for serial bonds retired, $14.39 for water supply, $11.56 for distribution expense, $10.67 for interest on bonds, $10.67 for general expense and $7.75 for miscellaneous expenses.

Mr. Anthony stated in his report to the Trustees that in 1949 more than one billion gallons of water was supplied making it the greatest use of water in any one year. More than 9,000 feet of water mains were installed, as well as 135 new water service connections and 10 new hydrants. Tables showing average water production, mains, gate valves, service connections and a history of Augusta water district complete the book.

MARION, IND., 1949 (32 pages), David Backmeyer, Supt. Ninth operational report. Average daily pumpage 4.871 mil. gal. Daily per capita flow 152 gallons. Average total cost for treatment of a million gallons of sewage $46.75. Receipts from sale of liquid sewage sludge fertilizer to farmers produced $2,454.55. Percentage of suspended solids removed 93.8. A total of 22,238.2 thousand cu. ft. of sewage gas were produced and 19,573.9 thousand cu. ft. were utilized in gas engines and boiler.

GARY, IND., 1949 (56 pages mimeograph) W. W. Mathews, Supt., Pumpage 19.94 mgd. or 199.4 gal. per cap. per day; 10,535 tons of suspended solids removed for an average of 0.171 lb. per cap. per day; 4,327 tons of reduction of 5 day B.O.D. Average gas production showed 1.64 cu. ft. per cap. per day, 2.7 cu. ft. per pound of solids added and 5.5 cu. ft. per pound of volatile solids added. Value of gas, $24,440.29. Operation costs show $13.71 per mil. gal., $0.9978 per cap. and $11.53 per 1,000 lb. 5 day B.O.D. removed. Complete operating tables are also included.

AURORA, ILL., 1949 (71 pages hectograph) Walter A. Sperry Supt. Report shows total receipts and cash on hand $277,403.94 and total disbursements of $114,975.82 for the year. Unit cost of processing sewage $49.62 per mil. gal., $2.05 per cap. per year and 17.1c per cap. per month. The plant produced 14,763,100 cu. ft. of gas which was used by the engines. The monthly average oxygen demand of the raw sewage in 1949 was 23 per cent less than for 1948. The oxygen demand of the effluent sewage was 22 per cent higher in 1949, the trickling filters operated 12 per cent of the time less in 1949 due to low gas and high river conditions.

MINNEAPOLIS-ST. PAUL SANITARY DISTRICT, 1949, (112 pages) Kerwin L. Mick, Chief Engr. & Supt., 43,045 mil. gal. of sewage treated in 1949. Flow per capita per day 131 gal.; suspended solids, raw sewage, lb. per cap. per day, 0.30; Biochemical oxygen demand, raw sewage, lb. per cap. per day 0.21. Industrial wastes amount to 20.4 per cent of the pollution load on the plant. The quantity of screen-

(Continued on page 106A)

See the flow!

Know the flow!

VISIBLE CHLORINE FLOW!

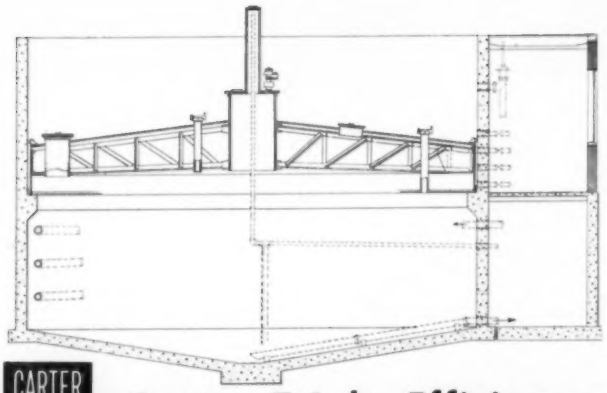
BUILDERS Chlorinizers

BUILDERS CHLORINIZER incorporates a true flow indicator — the SIGHTFLO indicator which measures ALL chlorine passing through the Chlorinizer and shows you the ACTUAL rate of chlorine feed on a direct-reading linear scale. Flow is indicated positively and accurately *only* when there is flow. It's another important feature of Builders Chlorinizer. For engineering information and Bulletins, address Builders-Providence, Inc. (Division of Builders Iron Foundry), 350 Harris Ave., Providence 1, Rhode Island.

BUILDERS PRODUCTS: The Venturi Meter • Propelaflo and Orifice Meters • Kennison Nozzles • Venturi Filter Controllers and Gauges • Conveyaflo Meters Type M and Flo-Watch Instruments • Wheeler Filter Bottoms • Master Controllers • Chlorinizers—Chlorine Gas Feeders • Filter Operating Tables • Manometers Chronaflo Telemeters

Installation at Gardner, Mass.

BUILDERS PROVIDENCE *Instruments*



CARTER FLOATING ROOF DIGESTERS

✓ *Faster, complete digestion*

✓ *Positive, controlled gas collection*

✓ *Reduced maintenance*

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Carter Triple Efficiency = Extra Economy

The Carter Floating Roof Digester reflects the latest engineering design and fabricating techniques—combined to produce more efficient and more economical sewage digestion equipment. Complete submergence of surface solids; positive, controlled gas collection and utilization; minimum maintenance costs—no mechanical operating equipment; flexibility controls digestion during draw-off, addition of solids or removal of supernatant liquids.

All equipment is stress analyzed, constructed of extra heavy duty ¼" steel plate, pre-assembled during fabrication, and match-marked for easy erection in the field. All appurtenances are Underwriter's Laboratory and Factory Mutual approved. Additional accessories available are supernatant selector, supernatant gage, sight glass and sampler, remote reading liquid level indicator and sludge heating equipment.

186 Atlantic St., Hackensack, N. J.

RALPH B. CARTER COMPANY
HACKENSACK, N. J.

Specify CARTER with confidence ....
ROTARY DISTRIBUTORS ● FLOATING & FIXED COVER DIGESTERS
ALTERNATING SIPHONS ● PADDLE AERATORS ● SLUDGE PUMPS
RAPID & SLOW MIXERS ● PNEUMATIC EJECTORS ● CIRCULAR
COLLECTORS ● FLOCCULATION EQUIPMENT ● DIAPHRAGM PUMPS
SELF-PRIMING CENTRIFUGAL PUMPS ● PLUNGER PRESSURE PUMPS

THE SILENT WATCHMAN

DIXIE TANK AND BRIDGE CO.

3523 LAMAR AVE. P. O. BOX 14
MEMPHIS 1, TENNESSEE

Complete Service for Elevated Water Tanks—
Nation Wide Service—30 Years Experience

KEEP THE SAFETY FACTOR IN YOUR TANK THE DIXIE WAY

By welding seams, pits and rivets which gives a riveted tank 15% more Safety Factor than it had when built. No rivets removed, water supply maintained while work is in progress. On completely reconditioned jobs, the painting is guaranteed for five years, repairs guaranteed for ten years, provided the tank is painted every five years by Dixie Tank and Bridge Company. Yearly inspection, making all adjustments, if any, without additional cost.

Write Us for Free Copy of Publication

SOUND PRINCIPLES OF WATER TANK MAINTENANCE and TANK TALK, by W. A. RILEY

—SAFETY—SERVICE—SATISFACTION—

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THE LARGEST ORGANIZATION OF ITS KIND GIVING SAFE MAINTENANCE AT LOW COST

(*Continued from page* 104A)

ings average 0.9 cu. ft. per mil. gal. of sewage and quantity of grit 4.7 cu. ft. per mil. gal. Grit averaged 10.2 per cent of volatile solids.

Breakdown on operating and maintenance costs show that 59.2 per cent went for salaries and wages for operation, 11.0 per cent for salaries and wages for maintenance, 12.2 per cent for materials and supplies for operation, 5.58 per cent for materials and supplies for maintenance, 5.0 per cent for power and light and 6.8 per cent for miscellaneous. Total cost for 1949, $503,940.28. Complete description of the plant and its operation plus a complete chart on analytical and operating data are included in the report.

District of Columbia, 1949, (19 pages mimeograph) Ralph E. Fuhrman, Supt., volume treated, 62 bil. gal. plus. Plant operated at 32 per cent above the design flow of 130 mgd. Costs were $4.45 per mil. gal. for treatment. Of this figure, pumping costs amounted to $1.13 per million gallons. Similarly, sludge shipping and cake disposal costs amounted to $0.54 per mil. gal. or $1.75 per ton of vacuum filter cake produced. Operating charts show suspended solids were reduced 39.7 per cent and B.O.D. was reduced 29.8 per cent.

Denver, Colo., 1949 (72 pages). George F. Hughes, Exec. Secy. Distribution of operating revenue shows 33.42 per cent for operation and maintenance, 15.26 per cent for depreciation, 33.41 per cent for interest and bond retirements and 17.91 per cent for invested capital. There were 29½ miles of distributing mains ranging in size from 3 to 16 in. installed in addition to several large feeder mains. The service division shows that services increased from 146,267 in 1948 to 175,014 in 1949. Average per capita consumption was 184 gal. per day.

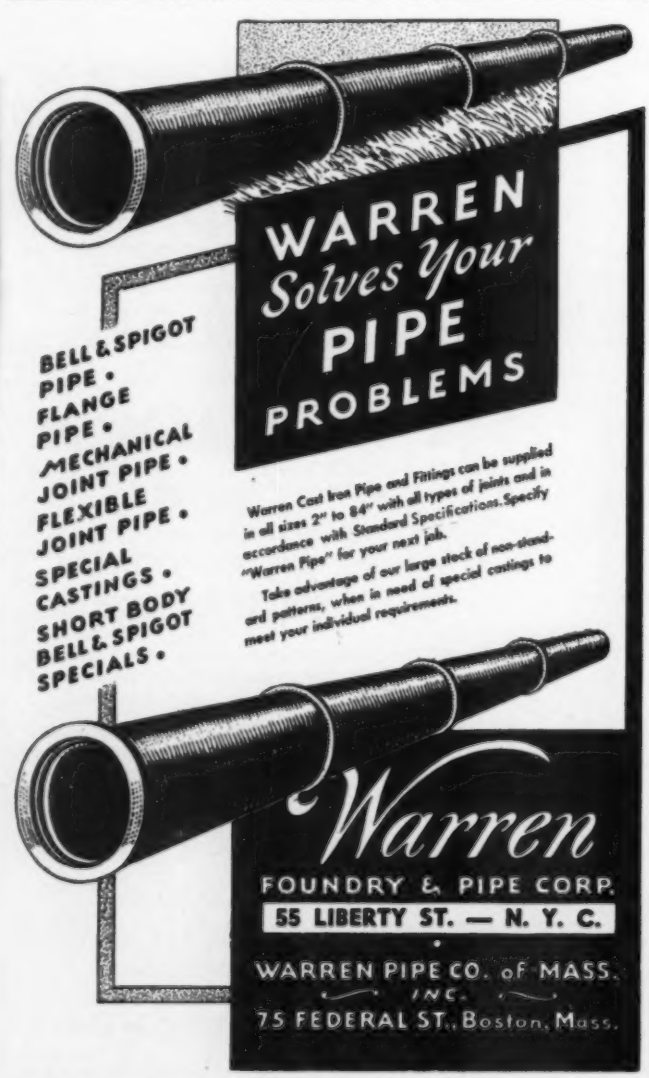
Several pages are devoted to tables showing the cost and maintenance of conduits, covering all sizes and types used by Denver. Sources of supply, graphs showing consumption, precipitation, temperature, etc., complete the book.

Elmira, N. Y., 1949 (36 pages). John G. Copley, General Mgr. Number of meters in service 16,874; an increase of 224 over previous year. New mains installed, up to 12 in., 14,815 ft. Average daily per capita use of water was 116 gal. The increased value of the Water Plant was $193,584.83 for the year bringing the total to $3,491,431.42. In this report the story is told of the development of the water supply system in Elmira. It covers the progress made from 1858 to date, including sources of supply, purification, treatment and distribution system. Tables are provided covering analysis of raw water, finished, property record balances, water used and services.

Athol, Mass., 1949 (21 pages), Robert W. Glasheen, Supt. Construction of new mains, 4,160 feet. Two new hydrants installed and one replaced. Installed 40 new meters, 41 new services and renewed 33 old services. The total amount of water filtered for the year was 338,050,000 gal. Financial statements and tables showing lengths in feet and sizes of water mains on each street complete the booklet.

Interstate Sanitation Commission, New York, New Jersey, Conn.) 1949, (36 pages mimeograph), Seth G. Hess, Director and Chief Engr. This report covers the progress made by the commission from its inception, orders of the commission, hearings, public relations, reports on the commission's inspections, special investigations, special activities, legal matters and acknowledgments. The report also contains maps, illustrations and diagrams of the area

(*Continued on page* 107A)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WATER & SEWAGE WORKS

Will see that you receive information desired.

(Continued from page 106A)
covered where the three states have mutual pollution problems.

NEW BRITAIN, CONN., March 31, 1950 (20 pages mimeograph), John R. Szymanski, Supt. Sewage treated Avg., 11.25 mgd. Grit removed 180 cu. yds. Suspended solids averaged 209 ppm. in raw sewage and 42 ppm. in final effluent. 5 day B.O.D. showed 187 ppm. in raw sewage and 52 ppm. in final effluent. Average cost per million gallons was $27.93. The report recommends the replacements of the present power mower with a new and larger machine and continued effort to improve the plant effluent to compensate the heavy overload at the plant.

LINDEN-ROSELLE, N.J., 1949, (25 pages mimeograph), Charles H. Gross, Vice Chairman. Installed 462 feet of 60-inch diameter sewer and appurtenances. Contract was signed between Linden - Roselle Sewerage Authority and City of Linden, N.J. and Borough of Roselle, N.J. (a copy of which is included in the report). Financial report shows contributions from Linden $68,426.06 and contribution from Borough of Roselle $17,818.67 and disbursements of $77,-718.56. Total estimated annual payments for 1950, $19,718.39.

WATER*

To Keep Taps Flowing, Nation Must Shell Out $3,250 Million by 1960

by

Michael J. Saada
Staff Correspondent
THE WALL STREET JOURNAL

This country is being urged to take out a $3,250 million insurance policy.

No, it's not against an A-bomb explosion or a polio epidemic.

It's against the day when you could turn on the water faucet in your kitchen sink and find nothing coming out.

That staggering sum must be laid out in the next 10 years to make sure that water will keep flowing to U. S. homes, farms and factories.

For this protection water users will have to pay a premium. Their cost for delivered water could go from

*This article occupied the front page of no less than *"The Wall Street Journal"* which printed the story on May 26, immediately following the A.W.W.A. Convention. Its use is admittedly rather tardy, but we think our readers will enjoy reading the account and seeing the marked attention which Water Supply has been receiving.

CLARK METER BOX COVERS
For Concrete and Tile

Complete, Economical Protection

Above, A-2-13 Clark Meter Box Cover with screw lock. Height 4" lid opening 13"

Left, A-2-11 Clark Single Lid Meter Box Cover, 4" throat. Also available in 6" and 9" throat.

Right, B-2-11-L Clark Double Lid Meter Box Cover, 6" throat. Also available in 4" and 9" throat.

The many types and sizes of Clark Meter Box Covers permit easy selection for any particular use. Careful design and rigid manufacturing processes assure permanence and protection against replacements. Standard Clark Covers withstand periodic load tests of 11,200 to 13,500 pounds, while extra heavy types withstand 21,400 pounds. All Clark Covers give complete protection to the meter. Available in sizes to fit 15" to 24" drums. Wonder Lock and screw lock covers available in 4" throat only.

Improved Screw Lock with strong forged bronze bolt.

Perfect Lock of one-piece manganese bronze forging.

Combination Key, available in meter and service box sizes.

Wonder Lock Lid (bottom view) showing forged bronze bars. Key of forged steel, cadmium plated.

write

H. W. CLARK CO.
MATTOON, ILLINOIS

today's average of 2¼ cents a person a day to 3 or 3¼ cents by 1960.

These water warnings come from men who should know—the superintendents and engineers who run the country's 15,400 water supply systems, public and private, big and little. Several thousand of them are here to attend the 70th annual get-together of their American Water Works Association.

Would Boost Construction

How do the aqua experts propose to provide the anti-thirst insurance? Through water system construction, for the most part. They caution that spending for that purpose in recent years has been a fraction of what it should be.

Louis R. Howson of Chicago's Alvord, Burdick & Howson, water system designers and engineers, says the country needs to plank down $325 million a year for 10 years to build up its water systems.

This target is finally being approached after a slow post-far start. Indications are that this year's construction spending will top $300 million. That would be about 50% above the 1949 outlay. In 1946-48, when many building materials were still in short supply, the annual average was a mere $135 million.

Use Rises with Population

By running short in some places in the past few years, water has seeped into the consciousness of millions of Americans who once took it for granted like the air they breathe. Most of them are in the East, the Midwest and the Southwest.

In parts of these regions, the race between water consumption and available supply, once no contest at all, has turned into a close affair.

In the Detroit area, says L. G. Lenhardt, general manager of the city's water board, population has increased about 30% in the past 10 years, "but we are using 45% more water now than we did in 1940." Aind the system, he adds, is operating at capacity.

Water consumption in Indianapolis has increased more in the past 10 years than in the preceding half-century, that city's water men say.

In Dallas, reports K. F. Hoefle, Water Department chief, "we're using nearly twice the amount of water that we did in 1940."

James E. Kerslake, Milwaukee water boss, says the city's population has risen only 12% since 1940, "but we are pumping almost 30% more water."

Other extra-thirsty areas include the New York City-northern New Jersey region, west Texas, parts of Texas' Gulf Coast and north central Illinois.

Behind the Thirst

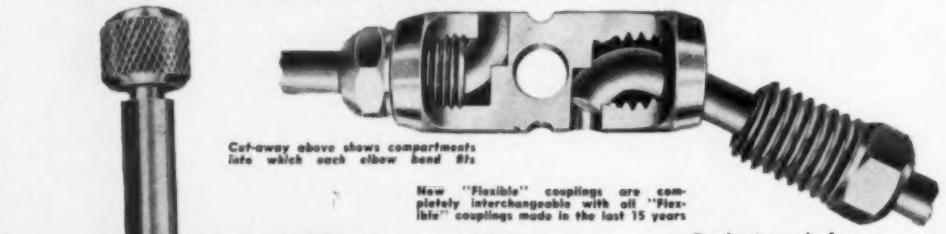
Why the water shortages? Droughts, population increases, delays in construction because of the war and greater use of water in air-conditioning systems and in some industries.

To sustain its domestic and industrial life, the U. S. now gulps some 13,200 million gallons of water every day. The annual tonnage of consumption is 13 times as much as the 1,500 million tons of freight carried by Class I railroads last year and 32 times the country's annual output of hard and soft coal together. Daily use now is a shade above this time last year, 5.6% greater than in 1945 and 14.8% above 1940.

A big drain on reservoirs has come about through the expansion of the chemical, paper and textile industries. Next to agriculture, they swallow about as much water as any of the nation's economic users. Their spread in the South and Southwest has put an extra load on the watersheds of many communities there.

Here's a sample of the textile mills' thirst for water: The Lyman, S. C., finishing plant of Pacific Mills uses 10

NEW "FLEXIBLE" COUPLING



Cut-away above shows compartments into which each elbow bend fits

New "Flexible" couplings are completely interchangeable with all "Flexible" couplings made in the last 15 years

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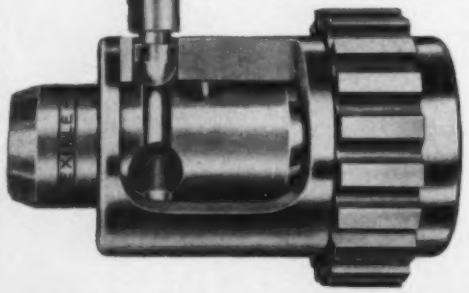

Simply move coupling in or out of ratchet or power drive shaft, and press point of pin down until it clicks. Then turn right or left for hole. What could be easier?

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gallons for every pound (about three yards) of cloth it turns out. Since the output is about 5,500,000 yards a week, the mill consumes more than 18 million gallons a week.

Air-Conditioning a Big User

And Americans' demonstrated liking for air-conditioning in stores, homes, theatres, bars, offices and factories is pushing this convenience ahead as a water consumer; many of the systems depend on rapid circulation of water for their cooling effect.

Just how much the air-conditioning systems use in all no one knows. But this will give you an idea: A fair-sized Midwest department store recently learned it would need 2,000 gallons of water a minute to operate a proposed air-conditioning system. This would amount to nearly three million gallons a day, or enough to supply a city the size of Billings, Mont., Yakima, Wash., Rochester, Minn., or Jefferson City, Mo. The store's request to the city for water was turned down.

Such developments have made the future look dry to many towns and cities. But they're now acting to try to dampen it.

New York Plans Big Outlay

New York City, the biggest and the thirstiest of all U. S. metropolises, plans to shell out a hefty $283 million for construction in the next 10 years. It's earmarked $140 million for developing new sources and a similar amount for building reservoirs. And don't forget that $50,000 rain-making experiment going on right now. There's been rain since the cloud-seeding started, but it isn't sure whether the rain-makers deserve the credit.

Gotham's water reserves have inched up to 88% of capacity from little more than one-third last fall, but a year ago the reservoirs were overflowing. Some officials of the Water Works Association describe the city as "living on borrowed water and by the grace of God" for the past five years.

Washington, D. C., its water flow spread thin because of a big population increase, expects to pay a thumping $48 million water construction bill in the coming decade. The nation's capital has plenty of water in the Potomac River, says E. A. Schmitt, its water supply chief. The trouble, he adds, is that distribution facilities "have reached overload capacity. No one could foresee this tremendous growth in population." Not even in a city of planners.

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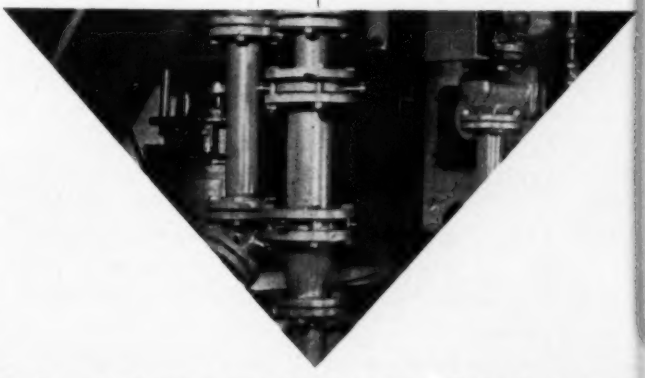

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Saran lined steel pipe is available in maximum lengths of 10 feet and in sizes from 1 to 6 inches inclusive. Also available are saran lined plug valves, Saunders type diaphragm valves, flanges, reducing flanges, flanged fittings, gaskets and fittings with union ends.

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Specify the Pipe with the Stripe!

CARLON "EP" PIPE

NOM. PIPE SIZE	O.D.	I.D.	EST'D B.P. P.S.I.	WT. PER FT.	NORMAL SHPG. LENGTHS
½"	0.840	0.622	540	0.103	400 ft. coils
¾"	1.050	0.824	350	0.140	400 ft. coils
1"	1.310	1.070	200	0.181	300 ft. coils
1¼"	1.660	1.380	200	0.267	300 ft. coils
1½"	1.900	1.610	200	0.330	250 ft. coils
2"	2.375	2.070	170	0.445	200 ft. coils
2½"	2.875	2.469	170	0.68	200 ft. coils
3"	3.504	3.070	165	0.91	100 ft. coils
4"	4.304	4.030	130	1.25	25 ft. str.
6"	6.630	6.070	115	2.23	25 ft. str.

Identification Stripe: WHITE—Standard Pipe; RED—Heavy-duty Pipe

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A Shortage of Facilities

Harry E. Jordan, executive secretary of A.W.W.A., agrees that distribution generally is the difficulty. He says enough water "can be obtained any place in the United States if communities have funds for this purpose. It's not water that's short; it's the facilities to bring it to the consumers."

Houston, with a post-war boom in population and industry and its only water source a series of wells around the city, plans to spend over $20 million to develop a surface supply and to build pumping stations.

To pay for such projects, some cities are going to have to raise rates. Morrison B. Cunningham, Oklahoma City's water chief, predicts higher real estate taxes, at least for a few years, to take care of his city's $10 million expansion program.

But Mr. Schmitt of Washington says rate increases won't be needed now despite the big outlay ahead—the capital upped its rates 25% two years ago. And Mr. Hoefle of Dallas hopes his city can get by without another boost—it had a 24% raise last year.

Texas Towns Join Forces

The distribution drought isn't all in the big cities. Out on the sun-parched plains of west Texas, several communities with critically low water supplies are talking up a plan to combine their resources to tap the region's Canadian River. One town alone can't afford such a project, but several can, they reason.

The scheme would be modeled on one started a few years ago in southern California. There a number of water-short communities got together and piped in an ample supply from the Colorado River, 300 miles to the east.

Los Angeles, though it's in arid southern California, has enough to quench the thirst of twice its present two million population. Its water is piped hundreds of miles from the Sierra Nevada Mountains and the Colorado River. Just the same, L. A. has ear-marked $120 million to be spent in the next five years, mostly on distribution.

Des Moines, Iowa, is a wet spot on the water map. Years ago, the city built an emergency reservoir that holds a 70-day supply, and it's never had to use it yet.

How True!

"The human brain is truly a wonderful thing. It starts working the moment you are born, and never stops until you stand up to speak in public."
—*The Canadian Underwriter.*

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"Copper Sulphate for Root and Fungus Control in Sanitary Sewers and Storm Drains," by John W. Hood, contains information published for the first time. This material includes actual methods for control and operating procedure. Here's the book that is a "must" for all sewage men.

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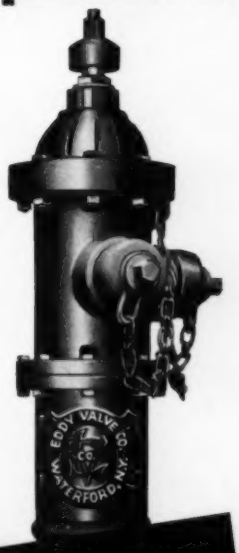

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Induction Motors

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TABLE OF COMPARATIVE QUANTITIES

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6	2.5	3.00	2.25	11.71
8	2.5	4.00	2.25	14.63
10	2.5	5.00	2.25	17.70
12	2.5	6.00	2.25	20.86
14	2.5	7.00	2.25	24.02
16	2.5	8.25	2.25	33.07
18	2.5	9.25	2.25	36.88
20	2.5	10.50	2.25	40.71
24	2.5	13.00	2.50	53.02
30	2.75	16.00	2.50	65.36
36	2.75	19.00	2.50	77.96
48	3.50	30.00	3.00	121.15
54	4.0	38.00	3.00	135.60
60	4.0	42.00	3.00	150.70

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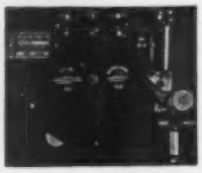

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Water Level Controls Division

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spection or cleaning without exposing the inside of the bearing. Similarly, the ample air-discharge openings in the side of the stator yoke, protected by removable louvers, facilitate vacuum cleaning or blowing out the air passages behind the stator core. Other new features have been added.

New Pipe Lining Company

Raymond Concrete Pile Co., New York City and American Pipe & Construction Co., Los Angeles, Calif., have organized a new company—Pipe Linings, Inc., to meet the growing need for cement mortar pipe lining of both small and large diameter pipe throughout the country. The new company will have offices at 140 Cedar St., New York City and at Terminal Annex, Los Angeles, Calif.

Tate Pipe Linings, Inc., who for years have been lining small diameter pipes, is in the process of dissolution and most of its equipment and some of its personnel have been acquired by Pipe Linings Inc., for which company Mr. Lewis (owner Tate Pipe Linings) will act as consultant.

Pipe Linings, Inc., in conjunction with the Centriline Division of the American Pipe & Construction Co., will be able to cover the entire field of pipeline reconditioning in cast iron, steel, concrete or tile mains in diameters from 4 inches and upwards. William A. Johnson, of American Pipe, is President of Pipe Linings Inc., J. W. Taussig of Raymond Concrete is Vice President, and J. P. Cummins is the Eastern General Manager.

1002

Self-Priming Pump

Goulds Pumps, Inc., Seneca Falls, N.Y., has announced a new line of

self-priming centrifugal pumps. These new pumps have unique features in self-priming applications, for example all valves are eliminated by the unusual design. Positive self-priming with no large bulky priming reservoir, no recirculation of water

When water conditions become unusually difficult, there's one reservoir that never seems to go dry: the reservoir of public criticism. But, long before this little shaver is ready to add his voice to the clamor, Welsbach-Ozone will have made complaints a thing of the past.

Taste, color and odor problems are now being solved quickly, efficiently and economically by ozone treatment utilizing equipment designed and manufactured by America's leading producer of reliable ozone units. Write to The Welsbach Corporation today. Without obligation, you can receive helpful suggestions on how Welsbach-Ozone stands ready to help you overcome your difficulties.

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"Hippocrates' sleeve" (a cloth straining bag) was a popular water treatment method in the 4th Century B.C.
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a clear liquid penetrating (1"+) sealer for concrete and masonry preventing water absorption and reducing the action of acids. Holds 12' hydrostatic head. Use our Hayproc Rubberized Enamel for color on walls and floors—not affected by concentrated acids, alcohol, oil, or traffic abrasion.

30 OTHER PRODUCTS
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ZECO GREENSAND ZEOLITE

ZECO and HI-ZECO Greensand Zeolite for water softening, filtration and iron removal. ZECO Manganese Zeolite for iron and manganese removal. COREXITE mineral for corrosion control and water stabilization.

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during pumping stage. Efficiencies are comparable to standard centrifugal pumps. Capacities up to 120 gpm. and heads to 135 feet with suction lifts up to 25 feet. This design is made in sizes from ¼ hp. to 5 hp., open and closed impellers.

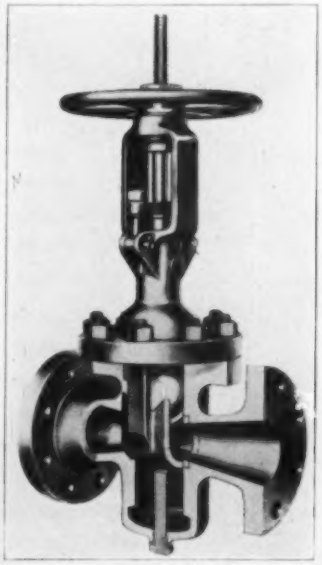
Potter to Represent Graver Water Conditioning

Graver Water Conditioning Co. of New York has announced the appointment of James T. Potter as its representative for the states of North and South Carolina. Mr. Potter has specialized in the field of water treatment for more than 20 years, and is well known to readers of this magazine. His headquarters are at 1521 Stanford Place, Charlotte, North Carolina. He will provide engineering and sales service on the Graver line of zeolite softeners, chemical feeders, filters and other equipment.

1003

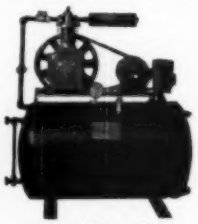
Venturi Ball Valve

W-K-M Co., Houston, Texas, announces a new valve for general duty, the W-K-M Venturi-Ball Valve. This new valve is especially



designed for throttling applications in high pressure, corrosive or erosive applications and features straight line discharge characteristics. In the throttling position, the ball presents a smooth surface, and nonturbulent flow is possible over a

KEEP PUMPS PRIMED FOR INSTANT USE



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Many successful installations . . . plants serving from 2500 to several million population . . . bear evidence of the carefully-designed units (patented) in the Jeffrey line for water and sewage treatment. Our engineers are specialists . . . will offer technical data on both equipment and design.

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wide range without destructive erosion or wire drawing.

Wide open flow is unobstructed, non-turbulent with negligible pressure drop. When closed the ball seats tightly, regardless of pressure and flow conditions. Line contact between ball and seat assures tight, absolute shut-off. The ball rolls upon opening or closing, making the valve easy to operate even under adverse conditions. By seating in a different position each time, wear is distributed over the entire surface of the ball.

U. S. Pipe & Foundry Buys Plant Site

United States Pipe and Foundry Co., Burlington, N.J., has purchased a 70 acre plant site in Decoto, Alameda County, Calif., according to General Donald Armstrong, President.

The plant has been designed by the company's engineering department and will be constructed by the Austin Co., and construction of the plant will begin immediately and is scheduled for completion in the last half of 1951. It will cost approximately $2,500,000 and employ about 125 men.

The plant will make use of the latest design machines and equipment and employ the most efficient methods to produce cast iron pipe centrifugally cast in metal molds. For the present, pipe in diameters four to twelve inches will be cast. This plant will be the first on the Pacific Coast to produce centrifugally cast iron pipe.

1004

Pipe Threader

The Ridge Tool Company, Elyria, Ohio, has announced an improvement in a pipe threader. The new Ridgid 65R Self-Contained Threader is now jam-proof. It threads 1 inch to 2 inch pipe with one set of high-speed steel dies, and sets the pipe size in a few seconds.

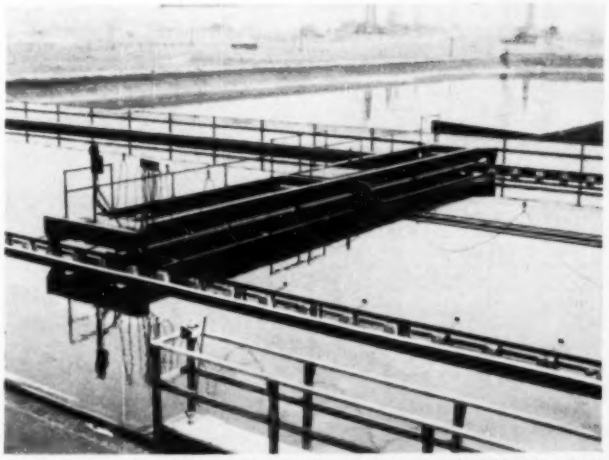
Hammond Iron Work's New Plant

Hammond Iron Works with main plant and offices at Warren, Pa., has just completed a new and modern plant at Bristol, Pa. This new fabricating plant features specialized equipment which enables the Hammond Iron Works to fabricate storage tanks, stacks, standpipes, breechings, steel and alloy plate, etc., of all sizes and design.

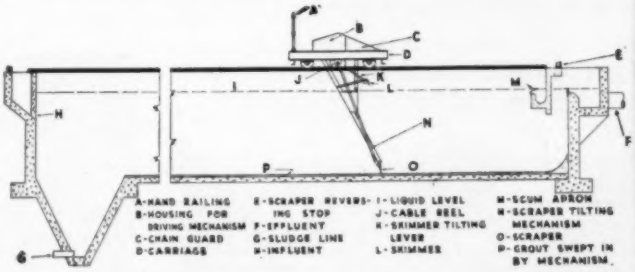
"Conserve space with

HARDINGE

Rectangular Clarifiers."



Typical Hardinge Rectangular Crane-Type Clarifier installation on industrial waste water.



In sewage or water treatment plants where space is limited, or where sludge delivery is desired at one end of the tank—the Hardinge Rectangular Clarifier provides a compact, efficient unit.

A traveling bridge crane spans the tank and supports a sludge scraper. This mechanism moves automatically along the tank, scraping all settled solids into sludge hoppers at one end. Skimmers are also available to remove floating impurities from the water's surface.

WRITE FOR BULLETIN 35-C-15 AND GIVE US PERTINENT DETAILS OF YOUR TREATMENT PROBLEM.

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PIPE DETECTORS

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FIRST WITH "SURE GRIP" HANDLE
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The new DETECTRON Model 505 locates, traces and centers pipes and cables with speed and accuracy. Small, compact, lightweight—with HEAVY DUTY PERFORMANCE.

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- LOWER PRICE

TRIPLE VALUE!

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THE Detectron CO.
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1005

Sewer Cleaner

Flexible Sewer-Rod Equipment Co., Los Angeles, Calif., has announced a new power machine which makes possible important economies by performing mechanically all the operations of rodding a sewer.

Called the "SeweRoder," the machine rotates special flexible steel rods, pushes the rods, pulls the rods and tugs back loads, requiring only

DARLEY MAGNETIC DIPPING NEEDLE
$17.50

with 3 section telescoping handle
$22.25

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Faithful Performance on Important Jobs
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Capacities to 1,200 G.P.M.
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TYPE-AD Aurora Horizontally Split Case, Back-to-Back Impellers, Two Stage Centrifugal Pump. Particularly suited to clear water and low viscosity liquids not containing solids. Write for BULLETIN 106

APCO TURBINE-TYPE PUMPS are unbeatable on low capacity, high head duties.

We carry popular sizes of Apco Pumps IN STOCK for immediate delivery.

AURORA CENTRIFUGAL PUMPS are available in many types and sizes —all noted for their streamline coordination between impellers and shells.

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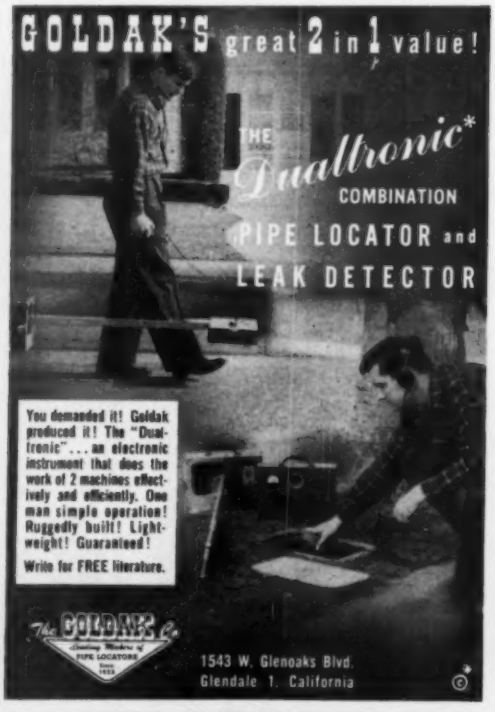

THE Dualtronic* COMBINATION PIPE LOCATOR and LEAK DETECTOR

You demanded it! Goldak produced it! The "Dualtronic"... an electronic instrument that does the work of 2 machines effectively and efficiently. One man simple operation! Ruggedly built! Lightweight! Guaranteed!

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one man and a helper for operation. It can be operated at speeds of up to 100 feet per minute, and an accurate footage meter makes it possible to keep track of the location of the tool in the line at all times.

Requiring a space of only 12 feet back of the manhole, the SeweRoder leaves no exposed rod on the street and provides full safety for the operator. Rods reel in and out of the container automatically.

Infilco Moves General Offices

Infilco, Inc., moved its research, development and engineering divisions, and General Offices to Tucson, Ariz., as of September 1. They will occupy temporary quarters at 2750 South Twelfth Avenue while a new building is being built.

Manufacturing, chemical laboratories, advertising and certain phases of engineering will continue in the present plant at 325 West 25th Place, Chicago. Plans are under way to increase the staffs of the New York and Chicago sales engineering offices.

1006

Saran Lined Valves

Dow Chemical Co., Midland, Mich., has announced the development of Saran lined Grinnell-Saunders Diaphragm Valves for handling corrosive fluids and gases.

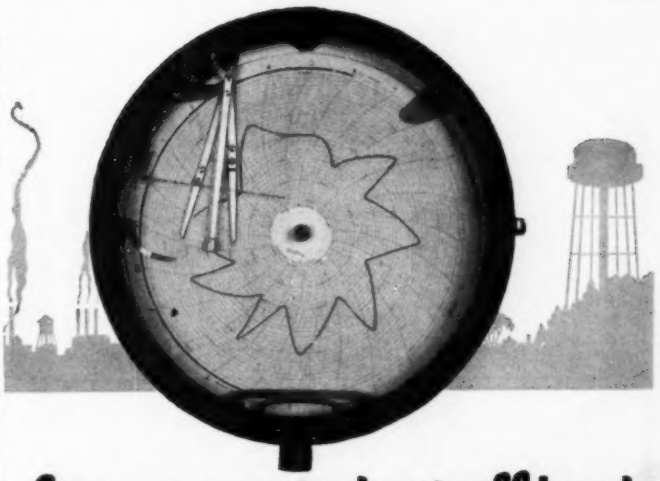
Special castings designed for the purpose are lined with B-115 Saran, the same material used in Saran lined pipe and fittings. They are furnished normally with diaphragms of Saran rubber, but diaphragms of natural rubber, neoprene, butyl, hycar and white neoprene are supplied optionally for special conditions. For extremely corrosive conditions and for high temperatures, diaphragms of Kel-F can be furnished at extra cost.

The valves are available in sizes 1 to 6 inches inclusive with flanged ends and are usually equipped for hand-wheel operation. Quick-opening lever operators, electric motor and air motor operators are readily available.

Golden-Anderson Elects New Gen. Mgr.

The board of directors of Golden-Anderson Valve Specialty Co., Pittsburgh, Pa., recently announced the election of Grant A. Colton as vice-president and general manager. Mr. Colton has served as assistant manager of the company since 1934.

Plans for a new Golden-Anderson sales program, extending into South



Can you control cut-off level as close as this?

With Foxboro Recording Rotax Control of water tower altitude, level is automatically and consistently held within limits impossible with pressure switches. A typical municipal installation, for example, employs a tank 30 feet deep, 150 feet above the pump station. With an instrument chart range of 120 feet to 150 feet, the Foxboro Rotax Controller holds the cut-off level to within 6" at all times!

Foxboro Recording Rotax Controllers are set directly to desired cut-off and start-up points, without fussing around or having to measure levels in the tower. Both settings are always readily adjustable by the operator. There's no need for wiring between tower and station because all measurements are made at the pump. And the chart records are constant proof that proper levels were maintained during fires or other emergencies.

Write for Bulletin 184-6 for further information on this simple, more accurate and dependable control for your tower level. The Foxboro Company, 228 Neponset Ave., Foxboro, Mass., U.S.A.

This exclusive Rotax assembly assures positive, unfailing pump operation. Its proven design overcomes disadvantages of ordinary electric controls. Maintenance is virtually eliminated.

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SEWAGE PLANT EXPANSION
. . . WITHOUT BOND ISSUE!

It's easy and economical to convert most overloaded sewage plants to the BIO-CHEMICAL PROCESS. Increase the capacity of existing activated sludge plants as much as 100% . . . small conversion costs can be paid for out of operating savings.

Get the most . . . the best . . . for the smallest possible amount of the taxpayer's money with the BIO-CHEMICAL PROCESS.

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FOR GATES TO 60 IN.
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America, also were revealed. Trade paper advertisements, publicity, and engineering bulletins will be utilized.

1007

Hydraulic Transmission for Ditcher

Barber-Greene, Aurora, Ill., has developed the "Hydracrowd" hydraulic transmission for the Runabout Ditcher. Except when in over-the-road travel speed, the operator has

full control of forward and reverse speed through a simple hydraulic valve.

This control might be likened to a conventional faucet for, as the valve is gradually opened, the speed of the machine increases up to a maximum of 16 ft. per minute. Rapid reverse of the machine, to clear obstructions, etc., is controlled by another hydraulic lever immediately adjacent to the speed control valve.

In addition to the multiple selection of feeding speeds thus available, there are three separate bucket line speeds which may be selected. This combination better enables the operator to handle the machine in any surface or underground condition.

To run the machine the operator can either stand on the ground or remain seated in the cab. All operations and controls are visible and accessible from either position.

G. F. Twist Vice Pres. Food Machinery Corp.

Food Machinery and Chemical Corp. has announced the election of Gerald F. Twist as Vice President. Mr. Twist has been manager of Peerless Pump Division with major plants located at Los Angeles and Indianapolis.

WANTED

Leading manufacturer of water pipe jointing compounds desires representation by manufacturers' agents in Eastern Missouri, Eastern Wisconsin, Illinois, Indiana, Michigan, Kentucky, Ohio, West Virginia, Western and Northeastern Pennsylvania, and Western New York. Address replies to Box 1048, WATER & SEWAGE WORKS, 155 East 44th Street, New York 17, New York.

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LITERATURE AND CATALOGS

1008
MIXFLO PUMPS

Worthington Pump and Machinery Corp., Harrison, N.J., has just released a new bulletin on the company's **Mixflo Pumps** with two-vane closed impellers. These pumps in types MC, MCC, MCF, MCV, MCZ sizes 10, 12 and 16, 60-cycle, are used for irrigation, drainage, sewage disposal, condenser circulating, and low-speed water supply.

The 16-page booklet includes line drawings, general data, performance curves, fittings of standard pumps, shafting charts, sizes of motor stands required for various motor sizes and dimensions.

1009
SLUDGE HEATER

Walker Process Equipment Inc., Aurora, Ill., has published a bulletin on their **Heat-X Digester Sludge Heater.** The bulletin describes some of the problems encountered since separate sludge digestion first came into practice. Advantages, operation and Btu requirements are described along with photographs and a schematic layout of a sludge digestion system using Heat. A cut-away diagram shows the function of all parts of the system and typical specifications are also included.

1010
ONE-MINUTE TESTS FOR WATER HARDNESS

Hall Laboratories Inc., Pittsburgh, Pa., have just issued a bulletin describing **Procedures, Reagents, and Equipment for OneMinute Water Hardness Tests.**

The tests are pictured and described and the bulletin states that the test procedure requires approximately one minute to complete, in contrast with the century-old "Soap-shaking" method. Because of clear-cut color change at the endpoint of the tests the subjective or human-error element is eliminated. Accuracy to within 1 ppm. has been demonstrated according to Hall Labs.

The new tests may be employed to determine total water hardness; hardness due to calcium alone; or hardness due to magnesium alone (this last simply by difference between total-hardness and calcium-hardness results.)

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The soil around Allentown, Pennsylvania, is largely limestone. One night, a passing automobile's vibration caused an entire street intersection to cave in over an unsuspected cavity. Gas mains exploded and water lines ruptured. The surge of water from the broken mains ate dangerously into the surrounding soil. Nearby structures were in danger of collapsing. As soon as practicable, one of our crews began the application of reinforced GUNITE over exposed rock surfaces (see photo above) to prevent air slacking and further undermining of the surrounding area. Our knowledge of how to cope with this situation was gained through actual experience in the construction of water tunnels in New York City, Baltimore, Boston, Toronto, as well as in many coal mines.

A completely illustrated catalog describing hundreds of successful GUNITE jobs we have performed is yours for the asking. A request for Bulletin C2400 will bring you a free copy by return mail.

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(ACTIVATED SILICA SOL)"
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This plant* also obtains these important benefits from the N-Sol-A coagulant aid—the basins are operated for longer periods between washings with only slight increase in wash water; a reduction in operating costs of 30-50%. Quality, of course, is improved in taste and sparkle of water.

N-Sol-A (U.S. Pat. 244,774) is produced from "N" silicate of soda reacted with ammonium sulphate. Other N-Sol processes use chlorine, alum or sodium bicarbonate as reactants.

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*Name on request.

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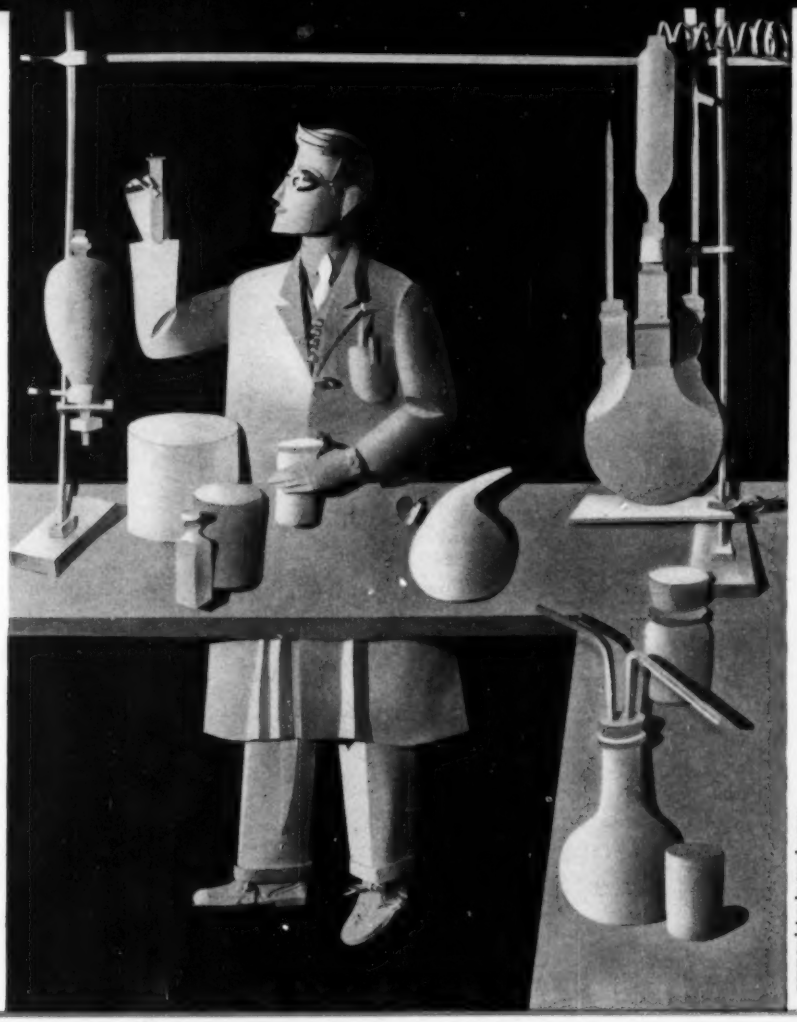

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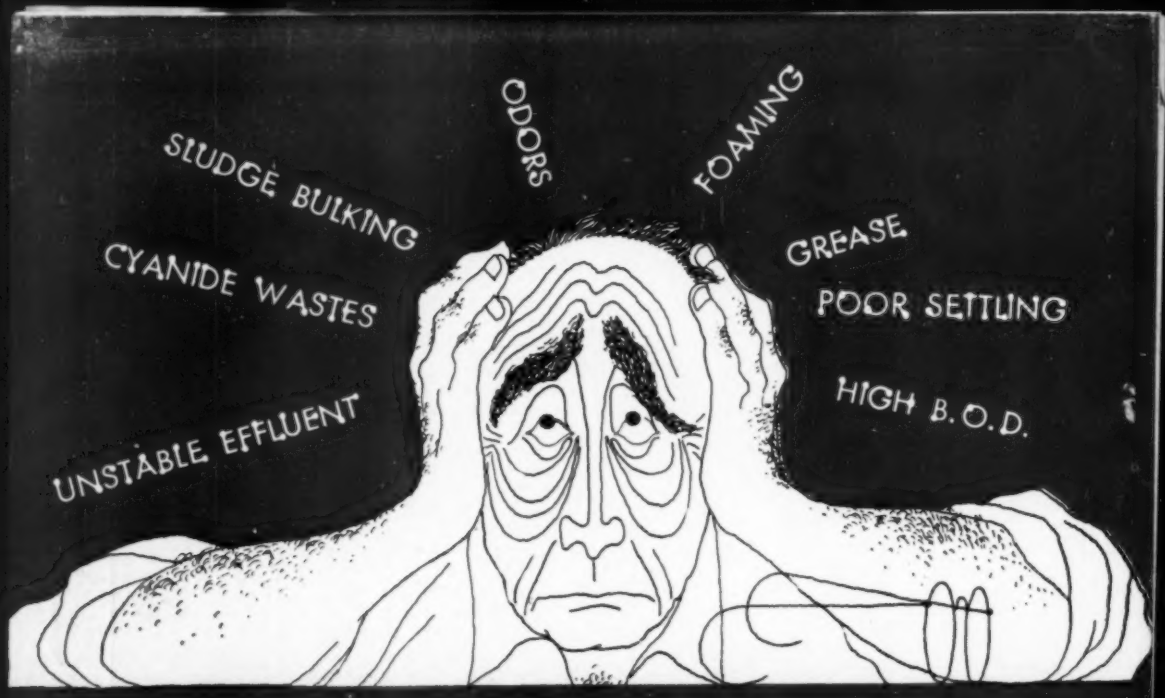

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